24th Congress, 1st Session. [Doc. No. 214.] Ho. of Reps.

CANAL—LAKE ERIE TO LAKE ONTARIO.

LETTER

FROM

THE SECRETARY OF WAR,

In relation to the construction of a canal from Lake Erie to Lake Ontario.

April 16, 1836.

Read, and referred to the Committee on Roads and Canals.

War Department,
April 14, 1836.

Sir: I transmit herewith a report of the Topographical Bureau, prepared in obedience to a resolution of the House of Representatives of the 3d ultimo, calling for information respecting the construction of a ship canal, to connect the waters of Lake Erie and Lake Ontario.

Very respectfully,
Your most obedient servant,
LEWIS CASS.

Hon. James K. Polk,
Speaker of the House of Representatives.

Topographical Bureau,
Washington, April 13, 1836.

Sir: I have the honor to submit herewith, a copy of the report, plan and estimates for the construction of a ship canal, to connect the waters of Lake Erie and Lake Ontario, made during the year 1835, under the direction of Captain W. G. Williams, United States topographical engineer, and called for by a resolution of the House of Representatives of the 3d of February last.

I am, very respectfully, sir,
Your obedient servant,
JOHN J. ABERT,
Lt. Col. Top. Engineers

Hon. Lewis Cass,
Secretary of War.

Blair & Rives, printers.

AUTHENTICATED U.S. GOVERNMENT INFORMATION GPO

Report of a survey around the Falls of Niagara, with a view to the construction of a ship canal, made during the year 1835, under the direction of Captain W. G. Williams, of the United States Topographical Engineers.

WASHINGTON, *March* 17, 1836.

Lieut. Col. J. J. ABERT,
United States Topographical Engineer:

SIR: By the letter from the Topographical Bureau, under date of the 14th April, 1835, I was ordered to repair to Utica, in the State of New York, and advise with the honorable Mr. Beardsley, on the subject of a projected ship canal around the Falls of Niagara, for a survey of which application had been made to the Department, by certain gentlemen of influence in the State of New York.

My instructions required that my maps and report relating to a survey on Delaware river, should previously be submitted to the bureau; this accomplished, I repaired to Utica, and presented myself to Mr. Beardsley, who referred me to the honorable Judge Turrill, of Oswego, for information in regard to the project contemplated. From Oswego, I was accompanied by the latter gentleman and Mr. McWhorter, also of that place, to Lewiston, where arrangements in regard to the expenditures incidental to the survey, were concluded.

Lieutenants Drayton and Reed having reported to me according to instructions, with the instruments necessary to accomplish the objects of the survey, I immediately commenced operations, the details of which, with results, and all that relate thereto, are embraced in the following report:

In order that the mind may be more prepared to comprehend at a glance the various details in regard to several lines of survey therein referred to, I think it proper to premise a cursory topographical sketch of the vicinity in which our operations were conducted.

Topographical sketch.

The section of country to which the project of the Niagara ship canal relates, is perhaps the most interesting on the American continent, whether we consider its geological formation, the incidents of a frontier war still fresh in the memory of every American, or its peculiar and magnificent characteristic, the cataract whose fame has reached the uttermost bounds of the civilized world.

The great waters of our northwestern possessions, covering an area of 150,000 square miles, bounded by a development of coast belonging to the United States of 3,294 miles, and of the British colonial possessions of 2,425 miles, are at length discharged through the narrow channel of the Niagara. It is from the head of this river, at the outlet of Lake Erie, to its termination on Lake Ontario, that the question of an artificial navigation arises, and forms the subject of the present report; and if only to achieve a conquest over the mightiest of nature's works involves a sentiment of sublimity, the feeling will not be impaired by the reflection that the conquest may be easily wrought; and when achieved, shall be the means of extending civilization, and promoting the social happiness of a large proportion of our country.

Indeed it cannot fail to excite astonishment, when the reflection is once led to the subject, that up to this epoch of an age resplendent with improvements in all that relates to the melioration of commerce and the advancement of civilization, this work, upon our own soil, and on a scale commensurate with its importance, should still remain to be executed. It needs not the aid of demonstration to prove its utility. It is one of those objects that strike us with instinctive conviction, and we are intuitively impelled to the belief of its comprehensive usefulness, even if abstraction be made of every thing but the general position; that it would connect two bodies of water, leading to the most remote regions, and capable of bearing upon their deep and expansive bosoms, the navies of the world in five seas, which are yet essentially separated, by reference to the scale of commercial enterprise that legitimately belongs to such a vast extent of geographical limit.

The Niagara river flows out of Lake Erie, in a direction nearly north, and separates in its whole course the United States from the Canadian provinces. It is about three-fourths of a mile wide, at its outlet, between which and Black Rock there are rapids having a current for a short distance of seven miles an hour. The river widens below Black Rock, and continues of an average width of one mile, until it reaches the great falls. The river embraces several islands in its course, the principal of which is Grand island; the rapids commence about one mile above the falls, in which distance is a descent of about fifty-two feet. The great falls are divided by Goat island, and another small island intermediate to this and the American shore. The perpendicular descent is 164 feet on the Canada side, and a few feet more on the American; but the great mass of water passes over the Horse-shoe falls on the Canada side. It has been estimated by Dr. Dwight, that the volume of water descending at this point amounts to 90,000,000 tons per hour.

The development of the curve formed by the edge of the precipice, is estimated between three-fourths of a mile and one mile. The distance from the outlet of Lake Erie to the great falls, is about twenty-two miles. From this point to Lewiston, about seven miles, the river rushes through a chasm in the Lewiston ridge, whose edges are about 350 feet above the surface of the water; the fall in this distance is about 103½ feet, and thence to Lake Ontario, two feet. Just above Lewiston the high ground suddenly ceases, and a descent of 216 feet occurs in a horizontal distance of 1,000 feet, measured on the projection of the line of greatest acclivity to the ridge. This brings us to the plateau of land on which the village is situated; hence a gradual slope characterizes the ground to the edge of Lake Ontario, about six miles, comprising a fall of 121½ feet. The features of topography on the opposite side of the Niagara, are very similar from the crest of the mountain at Queenstown heights to the lake.

The ridge appears to have been formerly continuous, and to have formed the southern edge of Lake Ontario, from which the waters have, at distant intervals, receded. This is shown by three distinct berms, generally parallel to the shores of the lake, but which eventually converge towards the Niagara river, between Lewiston and Fort Niagara.

It is evident, also, from the conformation of ground both at the falls and about Lewiston, that the waters of the upper lakes first burst their barriers at this point, and have since receded by degrees, breaking off large fragments from the edge of the precipice over which they have fallen; even

within the memory of man, it is asserted that a sensible difference exists in its configuration; and the fall of the table rock in the years 1818 and 1828, may be regarded as an illustration of the process by which this change is being gradually effected. If we may be allowed to speculate on the changes of a remote future, we may imagine prospective eyes to witness a gradual recession of the cataract towards the lake; the crest over which it falls assuming a lower plane, until it eventually sinks to, and becomes an element of a general slope, over which the great volume of the upper lakes shall flow. The waters of Lake Erie would recede from their existing limits, and their intermediate future outlines, would be only indicated by successive berms converging towards the outlet of the Niagara. This convergency of the several berms to the Niagara river, on the southern shore of Ontario, is, I think, a conclusive evidence, that this lake once occupied a higher level, and at different periods has occupied different elevations. In tracing these changes, we are insensibly led to the conclusion, from analogous reasoning, that the levels of the whole chain of lakes will eventually and successively change. That the St. Lawrence river may, in remote ages, have possessed a peculiarity similar to that which characterizes the Niagara, and that a point of time may exist in the vista of fututurity, when the strait between Erie and Huron, and finally between Huron and Superior, may boast a like phenomenon. In a word, that this will, at length, be worn away by the irresistible waters, and Superior find its way over one continuous and inclined plane to the broad bosom of the Atlantic. At the outlet of the Niagara, at the northeast extremity of Lake Erie, is situated Buffalo. This city, which a few years since might have been regarded as an insignificant village, has now become the principal emporium of the northwestern lakes, and cannot fail to retain its ascendancy over any other point upon the lake. Here the Hudson and Erie canal, which has been the source of its prosperity, has its outlet. The growth of Buffalo is an illustration of the advantages of this project, that every comprehension may realize. When we see a flourishing and refined community spring suddenly from the wilderness, we are made sensible, without reference to statistical records, of the amelioration that must be operating in a vast extent of country dependent upon it. It is a monument to art and commerce, that eloquently speaks of extended social happiness, of fields reclaimed from the desert, of industry and talent usefully employed, and of a thousand undefinable benefits to the human race.

The Hudson and Erie canal is conducted from Buffalo, along the margin of the Niagara river, to its intersection with the Tonnewanta creek, a little above its mouth, the creek being raised to the necessary level, by means of a dam. The channel of the Tonnewanta is made use of during a distance of eleven miles to the Pendleton village; thence to Lockport, about seven miles, the canal passes through deep cutting. At Lockport a fall of sixty feet occurs, which is overcome by five double consecutive locks to the long level; from this point it proceeds in an easterly direction to Troy and Albany, where it debouches into the Hudson river. From Lockport, the line upon which a portion of our survey was conducted diverges northwardly to its termination at the mouth of Eighteen-mile creek.

The great descent at Lockport is occasioned by the Lewiston ridge, which intersects the canal at this point. This steep declivity runs from he Niagara river, above Lewiston, to Lockport, without any intermediate

depression worthy of notice. It continues its course thence, in a direction nearly parallel to the lake.

The ridge as it becomes more remote from the Niagara river, generally becomes more elevated, to the limits to which my survey extended. The whole of this district of country is based upon nearly horizontal strata of lime and sand stone alternating; this exhibits itself most conspicuously in the chasm through which the Niagara flows; although it must be remarked, that localities exhibit discrepancies in regard to this rule, and that on the line of canal from Lockport west, there is some slight inclination of the strata beneath the horizontal. The first proposition, however, holds as a general geological feature. The slope below the ridge, down to the lakes, appears to consist of an alluvial formation, with a substratum of sand and lime stone. From the foot of the combined locks, at Lockport, to the mouth of the Eighteen-mile creek, which has its rise at this point, the ground is very uneven: at first a considerable descent takes place through a precipitous gorge for about two miles; thence a valley with low banks on either side for about five miles and a half; the intermediate distance between this and the mouth of the creek, would be a work of considerable difficulty, as there is a rocky bar which circumscribes the outlet. From this point to the mouth of Niagara river, it is eighteen miles, from which circumstance the creek derives its name.

From Fort Niagara, at the east side of the outlet of Niagara river into the lake, to the head of navigation, is about 7½ miles; the banks of the river in this distance are high and precipitous. The river, from Lewiston to its outlet into the lake, has a rapid current, but is accessible to every description of vessel navigating the lakes. This description comprises the area to which my report will refer. In its agricultural properties, it partakes of the character of this section of the country generally, possessing a rich alluminous soil, favorable to the growth of wheat and every product to which the climate is congenial: but there is one point of view in which this district offers advantages in a peculiar degree—namely, its manufacturing facilities. By way of illustration, we may regard the lake as being dammed by the Lewiston ridge, presenting a head of water of three hundred and twenty feet. This may be made available at almost any point of the ridge, and along the margin of the Niagara river, at a comparatively inconsiderable expense, by reference to the hydraulic power it would afford. My views in this respect will be further elucidated in the course of my report. I now proceed to details immediately referring to the plans and estimates of our survey.

Plan of canal.

The project under consideration contemplates a ship or steam-boat canal; and we assume for dimensions of locks and breadth of canal, proportions to render the work a means of transportation for the larger class of steamboats or sail vessels navigating, or that may navigate, Lakes Erie and Ontario.

We assume for the length of lock two hundred feet, breadth fifty feet, the width of canal one hundred and ten feet at the surface of the water, and depth ten feet. The locks will have a lift varying with circumstances, and generally not exceeding ten feet. It is obvious that the waters to supply the exigencies of lockage, &c. will be drawn from the Niagara river, the plane of the bottom of canal at its summit level intersecting it at ten feet below its minimum elevation.

My plan principally refers to a system of double locks to make the descent at Lewiston ridge, but an estimate for single locks for that object is embraced in my report. Map No. 2 will exhibit, on a horizontal scale of thirty-six inches to one mile, the descent by double locks, comprising an artificial harbor at Lewiston.

From the harbor to the outlet of canal on Niagara river, two modifications are shown on the map, one terminating at the steam-boat wharf, and the other at the ferry. Their expense may be regarded in a general estimate as nearly alike.

The line A B, debouching at a lower point of the river, although of greater development, would more generally be approved of, as avoiding an ascent against the current, for ascending vessels, of eleven hundred yards.

I have roughly estimated also the cost of a plan to descend the ridge by single locks, having an intermediate basin between each lock. It is found to be more expensive than the descent by double locks, by reference to their respective properties of speedy transit. This arises from the great cost of the outer or sustaining wall, and the advantage to economy of diminishing the length of line in its application to the side slope of the mountain; as this must be obvious, I have not introduced the estimate into my report.

In regard to the route of the contemplated canal, there have been different opinions; and several have been designated, having at least as much reference to local interest as to the general advantage of the project. Above the rest, and such as appear deserving of notice, are:

A line beginning at Porter's storehouse, near old Fort Schlosser, passing by Fort Grey, descending the ridge at that point, and debouching at Lewiston; this is the shortest line surveyed.

A line beginning as above, passing by Manchester village, and intersecting the preceding line; this has least deep cutting.

A line up the valley of Gill creek, descending the ridge through a depression at the head of Fish creek, and terminating on Lake Ontario, at the mouth of Mill creek. This location possesses advantages of a military character, by reference to the contiguity of the shore of a foreign power.

Local modifications of the above lines.

A line ascending the Cayuga creek, crossing the Lewiston ridge near Pekin, and debouching at the mouth of Twelve-mile creek.

A line debouching at the mouth of Tonnewanta creek, ascending the same to Pendleton village, descending at Lockport into Eighteen-mile creek, and keeping the valley to its mouth.

For the present, however, we shall confine ourselves to the investigation of the project by its shortest route, and eventually compare it with others to be hereafter referred to.

General description of route line No. 1.

Beginning at a point on the Niagara river denominated Porter's storehouse, and near old Fort Schlosser, the line of levels crosses Gill creek at a distance of half a mile above its mouth, and is carried nearly in a straight line to the head of Bloody run; the ground over which they pass after the first mile is generally swampy, although somewhat elevated, and for the first four miles, as determined by careful borings, no rock worthy of mention will occur, excepting a small portion at Gill creek; the soil is, however, by no means easy of excavation, being, as illustrated by the profiles,

in some parts of a tenacious character; the ground is swampy, covered with a heavy growth of timber, and will require draining.

From this point, the valley of Bloody run is pursued to within a short distance of the point where the run falls over the precipice into the Niagara river, at a small distance from the chasm known as the Devil's hole, three and a half miles below the great falls.

The levels now pass over unequal ground, but slightly elevated, however, until they reach the brow of the Lewiston ridge. This portion of the line was run very near the precipitous brink of the Niagara river, and only involves a prism of rock cutting of inconsiderable depth.

Until we arrive at Fort Grey, no obstacle of importance intervenes; indeed, none but the most commonplace circumstances of canal construction present themselves. It is from this point to the debouch of the project into the Niagara river that difficulties of a serious character may be apprehended.

From the brow of the ridge the lines of level were carried obliquely to the line of greatest acclivity of the ascent, falling in such proportion to the measured horizontal distance, as to render them conformable to the projected dimensions of the locks and basins, with the required lift for each lock. These data furnish the means of projecting a flight of double consecutive locks to the foot of the ridge, or a line of single locks, with intermediate basins, involving in either case a descent of 319½ feet from the bottom of the canal at Fort Grey, to the corresponding surface at its intersection, ten feet below the surface in Niagara river.

As the slope of the mountain may in a general view be regarded as uniform, and under an angle too great to admit of the location of the locks on a line approximating to that of greatest acclivity, it would be necessary, by means of excavation and embankment, to prepare a berm for their reception.

Our supposition involves a heavy mass of side cutting, so as to establish the exterior walls of the locks upon a well consolidated foundation; by this means the whole section of the locks and basins would possess a homogeneous basis, and have their stability insured.

This excavation comprehends the space to be occupied by the sustaining and interior walls, and in case the double locks should have their similar surfaces in the same horizontal plane, the breadth of their dividing walls would be comprised in the section.

In estimating the width of the berm necessary to the emplacement of the locks, we must regard as elements the strength and solidity or thickness necessary to their walls, to prevent lateral slides, or their overthrow by the pressure of water against them from within; and the space necessary to the working of the locks, which must of course occupy the upper surface of the walls. Precautions must be observed, to destroy the possibility of a thread of water from leakage or filtration, wearing itself a passage beneath the locks, throughout portions of the descent, and thereby acquiring sufficient head to act upon the foundations. In a system of consecutive locks of such extent as that before us, this principle of hydrostatics should be well considered.

Too much care cannot be observed in establishing the permanence and solidity of the work, and every applicable element of knowledge, theoretical as well as practical, must be brought to bear upon the subject, previously to a final adjustment of the plans.

In regard to experience, the realm of practical science does not exhibit a similar construction, and its light will therefore be but partially displayed. To compensate for this deficiency, abstract and general propositions of physical research must be carefully investigated, in reference to such modifications as may be involved, differing from those of works of a similar character already constructed.

This is a remark, it is true, that may be applied to every new project in some degree, but its emphasis is peculiar in regard to the one in question: in ordinary cases great masses of water find their way to lower levels, by gradual descent, and the plans of the engineer to surmount such obstacles have followed them up and vanquished them in detail. But at Niagara, nature has concentrated her powers, and by one stupendous effort has seemed to bid defiance to the art of man. The records of science do not exhibit an instance in which so great a fall is overcome in so small a distance, not even in a degree that will admit of comparison, much less when it is a question of a project, which, in the grandeur of its proportions, has no example.

It may be regarded as a national monument of art, from its general usefulness to the country; and although no pains be taken to render the project magnificent, in its very simplicity it will be so, and in congeniality with the stupendous obstacle it is intended to subdue.

Its effect will be grand and imposing in a vastly greater degree than in other, even more expensive, works; because it differs from them generally in possessing a concentration of human art, human industry, and physical means, applied to a single point.

As the line of levels descends to the foot of the ridge it gradually winds round until its horizontal projection becomes nearly parallel to its location at the beginning of the descent.

In order to obtain the direction which leads it to the most favorable point of debouch on the Niagara river, for the present modification of our project, I have planned a basin allowing sufficient room for the largest vessels admissible to the locks, to turn and assume its change of course. At this point the flight of locks would terminate in an extensive artificial harbor, comprizing an area of about 114 acres, and elevated 120 feet above the level of the Niagara river, it will be formed between the ridge on which the principal street of Lewiston is situated and the main ridge, possessing a mean depth of fourteen feet. The embankment necessary to back the water would be very inconsiderable.

It is an element forming a very important feature in our project, and would have the advantage of serving as a part of the canal, obviate a mass of expensive construction, and at the same time afford very essential accommodation to trade; indeed a basin of this kind would be almost necessary, by reference to the very contracted space which can be made available for the purpose of commercial transactions in the vicinity of the debouch, in connection with the precipitous banks of the river, and the violence of the current; moreover, the prism of water drawn from this reservoir, to supply the descent of the locks to the termination of the project, would be scarcely perceptible. This would render the descent from the harbor to the outlet, independent for its immediate exigencies, of the supply of water, to be drawn through the upper flight of locks from the summit level of the project.

At both extremities of the line above described, there is a navigable pas-

sage for vessels drawing even more than ten feet water into the lakes, namely, from Porter's storehouse into Lake Erie, and from Lewiston to Lake Ontario.

To confirm the assurance of this fact, I ordered a reconnoissance between Schlosser's and the outlet to Lake Erie; numerous soundings were taken by Lieutenant Drayton, from whose report I find there is no depth in the channel less than 14 feet.

It is a matter of notoriety, that there is water at the outlet of Niagara into Lake Ontario for vessels of any ordinary capacity; it was therefore deemed unnecessary to carry the investigation to that point.

On the whole extent of this route may be procured fine building materials for the locks, of every description; limestone is found in abundance, and hydraulic cement may be procured at a low rate.

These facts being premised, I proceed to the estimative details.

Line No. 1.—*See map and profile.*

For the purpose of draining the canal when necessary for repairing it, and because there is a rise and fall dependent upon winds and seasons in the Niagara river, a guard and regulating lock at the outlet of the canal is deemed expedient. Our observations during the time the survey was executing only detected a difference of level of five inches. By information, however, obtained on the ground, it appears to be considerably greater; and according to the statement of Mr. Geddes, an engineer well acquainted with the topographical facts connected with this section of the country, it varies to the amount of three feet, rising during the prevalence of certain violent winds, but seldom being depressed below the ordinary surface. Our levels refer to the lowest observed plane of its surface, at a time when the level is stated to have been at a minimum.

The lock walls, therefore, must be elevated four feet above the minimum level of the river; they will have a thickness of four feet at top and eight feet at the base. The dividing wall of lock will have a thickness of twelve feet. The estimate is as follows:

6,150.8 cubic yards of masonry for side walls, bottom of lock, &c. at 5.5	$33,829 40
For mitre sills, hollow quoins, at 14.2	8,657 00
Lock gates, with incidental work	1,500 00
200 running feet of walling in river, 444 cubic yards, at 2.5	1,110 00
Coffer dam to protect the foundation of the lock	6,666 00
Contingencies	5,176 24
Total	$56,938 64

The plan to which this estimate refers is an element common to all the experimental lines diverging from Porter's storehouse, and will be carried into the expenses of each. It embraces the idea of double locks, with such additional work as may contribute to a reasonable accommodation to trade. At a termination of this kind, many expensive additions may be suggested, not absolutely necessary to the primary object of the undertaking.

The amount of excavation for the locks, and its price, are involved in the annexed detailed statement of excavation and walling, and appears in the total cost for each line beginning at this point.

DETAILED STATEMENT of

Line No. 1, from Porter's store-

Section.	Mean ordinates.		Area in square feet.		Cubic yards, a running foot.		Price per cubic yard.	
	Rock.	Clay.	Rock.	Clay.	Rock.	Clay.	Rock.	Clay.
Mile 1st. 1st qr.	–	12.70	–	1416.565	–	52.465	–	0.143
Mile 1st. 2d "	2.58	10.88	261.328	1244.218	9.6788	46.082	0.63	0.136
Mile 1st. 3d "	2.92	12.63	296.263	1500.114	10.9727	55.559	0.63	0.142
Mile 1st. 4th "	0.30	18.75	30.045	2250.507	1.1130	83.352	0.63	0.165
Mile 2d. 1st qr.	–	23.42	–	2924.011	–	108.297	–	0.018
Mile 2d. 2d "	–	25.75	–	3282.062	–	121.556	–	0.185
Mile 2d. 3d "	–	26.90	–	3462.078	–	128.251	–	0.019
Mile 2d. 4th "	–	27.65	–	3582.007	–	132.067	–	0.019
Mile 3d. 1st qr.	–	29.75	–	3922.006	–	145.261	–	0.020
Mile 3d. 2d "	–	29.15	–	3824.002	–	141.063	–	0.195
Mile 3d. 3d "	–	25.00	–	3165.625	–	117.245	–	0.018
Mile 3d. 4th "	–	23.90	–	2996.885	–	110.996	–	0.018
Mile 4th. 1st qr.	–	25.40	–	3227.058	–	119.054	–	0.185
Mile 4th. 2d "	–	20.75	–	2527.006	–	93.595	–	0.017
Mile 4th. 3d "	1.40	16.70	140.098	1811.018	5.221	67.091	0.63	0.155
Mile 4th. 4th "	2.15	11.25	217.311	1002.058	8.049	47.484	0.63	0.014
Mile 5th. 1st qr.	2.09	9.45	294.205	1065.006	10.896	39.447	0.63	0.013
Mile 5th. 2d "	1.67	8.03	168.394	881.097	6.237	32.666	0.63	0.013
Mile 5th. 3d "	1.50	18.10	151.125	1990.006	5.597	73.706	0.63	0.016
Mile 5th. 4th "	2.60	3.70	263.038	401.265	9.756	14.862	0.63	0.011
Mile 6th. 1st qr.	1.80	3.60	181.062	387.036	6.727	14.347	0.63	0.011
Mile 6th. 2d "	2.00	18.15	202.000	2069.079	7.482	76.659	0.63	0.016
Mile 6th. 3d "	2.50	23.15	253.125	3003.035	9.375	111.235	0.63	0.175
Mile 6th. 4th "	5.50	15.50	565.125	1976.005	20.931	73.204	0.64	0.015
1st 8th, Mile 7	11.17	8.16	1179.384	1097.069	43.681	40.655	0.66	0.013

estimates for excavation and walling.

house to Niagara river, at Lewistown.

Price each qr. of a mile. Amount.	Walling. Cubic yards per qr. mile.	Price each cubic y'd.	Amount.			
$9,903 29	2248.08	1.20	$2,698 56	Walling -	$9,433 56	
16,321 57	1744.04	1.20	2,093 28	Excavation -	64,842 38	
19,537 88	1677.09	1.20	2,013 48			
19,079 64	2190.02	1.20	2,628 24	Total -	-	$74,275 94
25,730 37	2248.08	1.20	2,698 56	Walling -	$10,794 24	
29,683 98	2248.08	1.20	2,698 56	Excavation -	120,853 34	
32,165 35	2248.08	1.20	2,698 56			
33,273 64	2248.08	1.20	2,968 56	Total -	-	$131,647 58
38,348 90	2248.08	1.20	2,698 56	Walling -	$10,794 24	
36,455 56	2248.08	1.20	2,698 56	Excavation -	129,034 52	
27,857 41	2248.08	1.20	2,698 56			
26,372 65	2248.08	1.20	2,698 56	Total -	-	$139,828 76
29,191 67	2248.08	1.20	2,698 56	Walling -	$9,961 24	
21,002 72	2248.08	1.20	2,698 56	Excavation -	83,733 26	
18,068 47	1975.01	1.20	2,370 13			
15,470 40	1828.03	1.20	2,193 99	Total -	-	$93,694 50
15,830 22	1681.08	1.20	2,018 16	Walling -	$8,760 10	
10,792 01	1922.03	1.20	2,306 76	Excavation -	57,113 45	
20,221 17	1955.05	1.20	2,346 66			
10,270 05	1740.04	1.20	2,088 52	Total -	-	$65,873 55
7,677 36	1896.89	1.20	2,276 26	Walling -	$8,025 54	
24,413 41	1857.77	1.20	2,229 32	Excavation -	95,759 21	
33,491 54	1760.00	1.20	2,112 00			
32,176 99	1173.03	1.20	1,407 96	Total -	-	$103,784 75
22,515 64	32.266	1.20	38 72	Walling -	$38 72	
				Embankment	22,515 64	
				Total -	-	$22,554 36
						$631,659 44

Vide preceding statement, from which the amounts are brought over.

		Amount.	Total.
Line No. 1.—1st Mile. The section of the canal is shown on the profiles. The sides of canal, in the ordinary ground through which the line is conducted, will be revetted with stone to resist the abrasion, which would otherwise occur from a navigation by steam. On the above mile will occur the necessity for a culvert, at the intersection of the line with Gill creek. The number and character of bridges will be better defined by the estimate for rigorous location. This and other incidental expenses are comprised in the allowance for contingencies. On this mile, a portion of rock cutting occurs, sufficient for *purposes of walling*.	We have therefore, for the cost of the 1st mile on line No. 1—		
	1st Mile.		
	Guard and regulating lock, as already estimated - -		$56,938 64
	Excavation in rock and clay - -	$64,842 38	
	Walling - -	9,433 56	
	Grubbing and clearing	1,700 00	
	Contingencies -	7,597 05	
			83,573 03
2d Mile. In this mile, we have some deep cutting in clay, but no rock. The mean depth of cutting is 26 feet. The ground is flat and swampy, and in part heavily timbered. Draining will be required in many portions of this mile.	*2d Mile.*		
	Excavation in clay -	120,853 34	
	Walling - -	10,794 24	
	Grubbing and clearing	1,800 00	
	Contingencies -	13,344 75	
			146,792 33
3d Mile. 4,280 feet of this mile is heavily timbered and swampy; the soil, gravel, clay, and hard-pan; about 1,000 feet is cleared timber. The mean depth of cutting is about 27 feet.	*3d Mile.*		
	Excavation - -	129,034 52	
	Walling - -	10,794 24	
	Grubbing and clearing	1,500 00	
	Contingencies -	14,132 87	
			155,461 63
4th Mile. 1,060 feet heavily timbered and swampy. 4,220 feet cleared ground, clay, and rock. Mean depth of cutting, 17.5 feet.	*4th Mile.*		
	Excavation in clay and rock - -	83,733 26	
	Walling - -	9,961 24	
	Grubbing and clearing	1,000 00	
	Contingencies -	9,469 45	
			104,163 95
5th Mile. Ground lightly timbered.	*5th Mile.*		
	Excavation in rock and clay - -	57,113 45	
	Walling - -	8,760 10	
	Grubbing and clearing	700 00	
	Contingencies -	6,557 35	
			72,130 90
6th Mile. Ground lightly timbered; clay and rock.	*6th Mile.*		
	Excavation in clay and rock - -	95,759 21	
	Walling - -	8,025 54	
	Grubbing and clearing	50 00	
	Contingencies -	10,383 47	
			114,218 22
Portion of 7th mile to crest of ridge. Cleared ground; clay and rock.	*Portion of 7th mile to crest of ridge.*		
	Excavation - -	22,515 64	
	Walling - -	38 72	
	Grubbing and clearing		
	Contingencies -	2,554 36	
			25,108 66
	Total cost of line No. 1, from Porter's storehouse to crest of ridge at Fort Grey -	-	$758,387 63

Thus far the project would only be distinguished by the grandeur of its dimensions: the difficulties to be surmounted being those only of an ordinary character. The maximum of deep cutting does not exceed, for any considerable distance, a depth of twenty-five feet, and that only in a character of ground not to oppose unusual obstacles to its excavation.

But we now arrive at a point of our project from which the utmost care is required, not only in the selection of plan, but in its judicious location. To project upon the side slope of a ridge of solid rock a series of locks of such magnitude, is a novel circumstance in civil engineering: simply to locate a line of canal upon a side hill, is a common place occurrence. The mass of excavation and embankment being homogeneous, the equalization resolves itself into a problem of easy solution; but it is in this case a question of establishing the sustaining walls of the locks, in a manner to strengthen their foundations, by inserting them in the well consolidated formation of the mountain ridge.

This is necessary, that they may be enabled to sustain the pressure of a head of water of twenty feet, withstand the shock of locking operations, and procure a perfect impermeability to the exterior portion of the bottom of the locks, which may project beyond the natural slope of the ground. Our plan purposes to give the sustaining walls a slope of one-fifth: this was likewise adopted as the angle under which the rock should be left, on the interior face of our excavation.

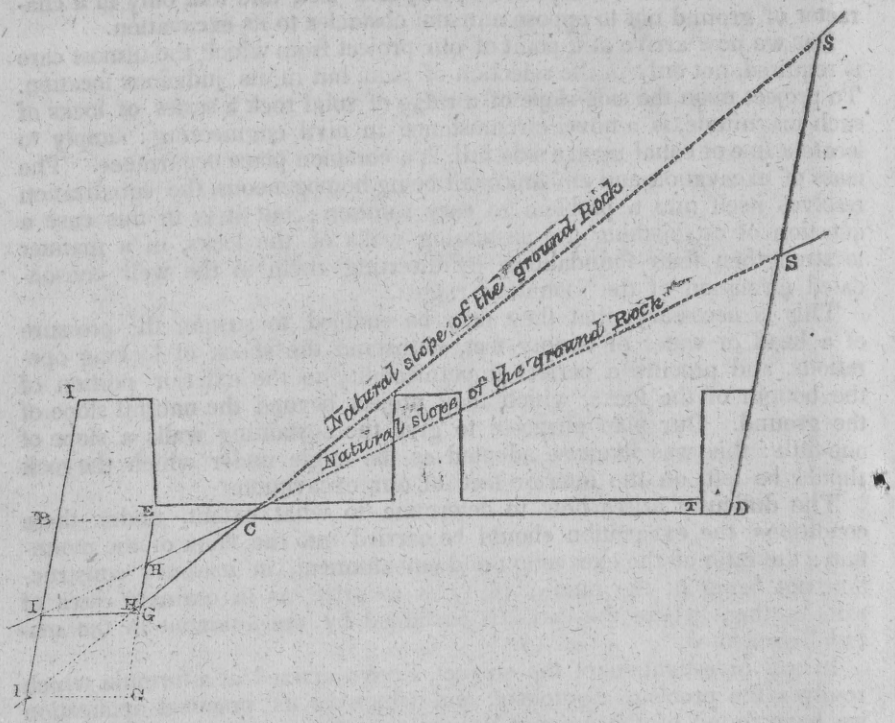
The difficulty arises how to determine to what extent, under these conditions, the excavation should be carried into the flank of the mountain: the ratio of the excavation and embankment, in masonry construction, not being in the ratio of unity as to price, as in ordinary cases of side cutting, where the canal is sustained by embankment in the material excavated.

In my investigation of the subject, I have arrived at a formula which resolves the problem rigorously, and which in its practical application we have found of the greatest utility in making our estimate.

We have deduced from it tables which have greatly facilitated our plans and estimate. These, which for our present purpose are sufficiently nearly calculated, and will exhibit the principle, are appended in the following note. The solution is also presented, that the formula may be understood and rendered available when the work shall be constructed.

I believe it to be entirely new, probably because its application has never been so extensively needed as in the present instance.

Note.—The following note, with the annexed figure, which exhibits cases of our sections, will illustrate the discussion:



Let us suppose SI to be the slope at the point where our section is taken The wish to establish such a relation between the area BEHI+GHI, and the area CSD, as may conform to the difference in expense between the mass of masonry construction and the simple excavation, so that no useless expense of the one or the other may occur, as would be obviously the case, should the depth of cutting not be properly determined. The condition of the question are therefore as follows:

Let BD = to the assumed breadth of locks, sustaining and dividing wall = a.

BE = the breadth assumed at the base of sustaining walls = h.

$\frac{c}{d}$ = the ratio between the price of excavation and that of embankment, or masonry construction of sustaining walls = $\frac{1}{R}$

CD = y. = the value to be determined in the hor. plane of the bottom of the locks, as located by the lines of levels: being the distance perpendicularly to the projected line of level, at any point, to which the excavation is to be carried into the flank of the ridge, from known point "C," on the surface of the ground. CE = the distance from C to the exterior angle of side wall and bottom of lock, also to the determined = x.

Area CSD = M
CEH = A'
CBI = A''
GHI = A

$$A'' : M :: (x+h)^2 : y^2 \qquad A'' = \frac{M\,(x+h)^2}{y^2}$$

$$A : M :: h^2 : y^2 \qquad A = \frac{M\,h^2}{y^2}$$

$$A' : M :: x^2 : y^2 \qquad A' = \frac{M\,x^2}{y^2}$$

$$A'' + A - A' : M :: c : d \qquad a = h + y + x$$

$$A'' + A - A' = \frac{M\,c}{d}$$

$$A'' + A - A = \frac{M\,(x+h)^2}{y^2} + \frac{M\,h^2}{y^2}\ \frac{M\ -x^2}{y^2}$$

$$\frac{M\,c}{d} = \frac{M\,(x+h)^2 + M\,h^2 - M\,x^2}{y^2}$$

$$\frac{c\,y^2}{d} = (x+h)^2 + h^2 - x^2$$

$$\frac{c}{d} = \frac{1}{R}$$

$$y^2 = R\,(x^2 + 2\,h\,x + h^2 + h^2 - x^2)$$

$$y^2 = (2\,h^2 + 2\,h\,x)\,R$$

$$y^2 = 2\,R\,h^2 + 2\,R\,h\,x$$

By conditions of the question—

$$a = x + y + h \text{ hence } x = a - y - h$$

$$y^2 = 2\,R\,h^2 + 2\,R\,h\,(a - y - h)$$

$$y^2 = 2\,R\,h^2 + 2\,R\,a\,h - 2\,R\,h\,y - 2\,R\,h^2$$

$$y^2 + 2\,R\,h\,y = 2\,R\,a\,h$$

$$y + R\,h = \pm\sqrt{R^2\,h^2 + 2\,R\,a\,h}$$

$$y = \pm\sqrt{R^2\,h^2 + 2\,R\,a\,h} - R\,h$$

$$y = \pm\sqrt{R\,h + 2\,a + R\,h} - R\,h$$

This solution supposes the case where the area HIG is involved, to insure a greater degree of stability to the sustaining walls. This is of course essential when the slope is great. Under a light slope a modification may be made of the principle, by rejecting the area HIG, and making a judicious allowance for the small quantities of masonry, necessary to insert the foundation, by steps or offsets.

The rigorous formula under this hypothesis would revolve itself into the following:

$$y = \pm\sqrt{(R+1)\,h + 2\,a \times R\,h} + R\,h$$

and between these two limits of the value of y, lie every variety of modification of which the area HIG is suceptible.

Under extremely small slopes, the prism ECH would be extremely small, and may therefore be disregarded, and the question would resolve itself into the comparison of the ratio between CSD and CBI; under this supposition, I deduce the formula $\frac{a\sqrt{d}}{\sqrt{c}+\sqrt{d}} = y$

in which $\frac{c}{d}$ is the ratio of prices, as explained at the beginning.

Finally, if we assume the value of $\frac{c}{d}$ in this last equation equal to unity, it resolves itself into the result $y = \frac{1}{2}a$, as it should do, for the simple case of excavation and embankment. We have thus the three equations:

$$y = \tfrac{1}{2}\sqrt{\mathrm{R}\,h + 2a \times \mathrm{R}\,h} - \mathrm{R}\,h$$

$$y = \tfrac{1}{2}\sqrt{(\mathrm{R}+1)\,h + 2a \times \mathrm{R}\,h} - \mathrm{R}\,h$$

$$y = \frac{a\sqrt{d}}{\sqrt{c}+\sqrt{d}}$$

answering to the three cases, for great, intermediate, and very small slopes. The mean taken between the values of y in the two first formula for similar values of R, modifies the area HIG to any adopted project, having HIG for the maximum area.

In very great angles, and beyond the limit called for in our location, it might be desirable to reduce the slopes assumed for the excavation and sustaining walls; and even when the rock is of a certain consistency, to regard them as perpendicular to the horizontal plane, as in that case, the space required by the slope of the exterior wall, although conducing to its stability, would be too dearly purchased, by the greater depth of cutting it would necessitate. It would therefore have to be compensated by the thickness of walls. It is obvious that the formula applies to all cases where the faces are parallel, as it is entirely independent of any angle.

This principle judiciously and understandingly applied upon the ground, would contribute greatly to procure a minimum of expense to this difficult part of our project.

The annexed table exhibits the variable masses deduced from formula, No. 1, in their application to our plan for different degrees of slopes. The values of y, and the corresponding ordinates, are found under their respective heads.

The section adopted for this portion of our location, is exhibited on the margin of map No. 2, in which the plan of location, embracing artificial harbor, &c. are likewise represented.

The basins are located by reference to any accidental obstruction that might occur to one set of locks. They would enable vessels to turn out and enter the other, and proceed until the cause of delay should be obviated.

I now proceed to the detail of estimate for the descent of Lewistown ridge, by double locks.

DOUBLE LOCKS.

Formula $+\sqrt{(Rh+2a)\,Rh}-Rh=Y$. R = ratio. h = 19.7 feet. a = 135.7 feet.

	Ratio. 1.			Ratio. 2.			Ratio. 3.			Ratio. 4.			Ratio. 5.			Ratio. 6.			Ratio. 7.		
Angles of slopes.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.
55°	117.3	56.6	117.3	189.3	71.7	94.65	242.69	81.3	80.89	286.79	88.7	71.69	317.9	93.	63.58	346.3	97.1	57.71	369.99	100.3	52.85
50°	91.67	44.2	91.67	148.67	56.3	74.33	190.1	63.7	63.36	222.77	68.9	55.69	248.86	72.8	49.77	271.4	76.1	45.23	289.9	78.6	41.42
45°	73.2	35.3	73.2	118.56	44.9	59.28	151.64	50.8	50.54	177.8	55.	44.45	198.27	58.	39.65	216.14	60.6	36.02	229.08	62.1	32.72
40°	58.9	28.4	58.9	95.3	36.1	47.65	122.09	40.9	40.69	143.2	44.3	35.8	159.6	46.7	31.92	174.7	49.	29.11	187.39	50.8	26.77
35°	46.87	22.6	46.87	77.1	29.2	38.55	98.5	33.	32.83	115.4	35.7	28.85	128.87	37.7	25.77	140.5	39.4	23.41	150.13	40.7	21.44
30°	38.16	18.4	38.16	61.5	23.3	30.75	79.1	26.5	26.36	92.79	28.7	23.19	103.58	30.3	20.71	112.7	31.6	18.78	120.6	32.7	17.22

DOUBLE LOCKS—Continued.

Angles of slopes.	Ratio. 1.			Ratio. 2.			Ratio. 3.			Ratio. 4.			Ratio. 5.			Ratio. 6.			Ratio. 7.		
	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.
25°	30.07	14.5	30.07	48.58	18.4	24.29	62.39	20.9	20.79	72.7	22.5	18.17	82.04	24.	16.40	92.02	25.	15.33	95.17	25.8	13.59
20°	23.	11.1	23.	36.9	14.	18.45	47.46	15.9	15.82	55.6	17.2	13.9	62.2	18.2	12.44	69.55	19.5	11.59	72.67	19.7	10.38
15°	16.5	8	16.5	27.7	10.5	13.85	34.3	11.5	11.43	40.4	12.5	10.1	45.1	13.2	9.02	49.2	13.8	8.2	52.38	14.2	7.48
10°	10.78	5.2	10.78	17.69	6.7	8.84	22.38	7.5	7.46	26.18	8.1	6.54	29.39	8.6	5.87	32.1	9.	5.3	33.93	9.2	4.84
5°	5.18	2.5	5.18	8.7	3.3	4.35	11.04	3.7	3.68	12.9	4	3.22	14.3	4.2	2.86	15.3	4.3	2.55	16.6	4.5	2.37
Value of Y in feet.		56			71.3			80.6			87.3			92.3			96.3			99.6	

DOUBLE LOCKS—Continued.

Angles of slopes.	Ratio. 8.			Ratio. 9.			Ratio. 10.			Ratio. 15.			Ratio. 20.			Ratio. 25.			Ratio. 30.		
	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.
55°	391.77	103.3	48.97	409.88	105.7	45.54	426.8	108.	42.68	466.59	110.8	31.1	521.3	119.3	26.06	544.04	121.6	21.7	564.88	124.1	18.80
50°	307.2	81.	38.4	321.46	82.9	35.71	333.45	84.4	33.35	379.	90.	25.2	413.	94.5	20.65	427.27	95.5	17.09	443.35	97.4	14.77
45°	244.24	64.4	30.53	255.15	65.8	28.35	265.5	67.2	26.55	296.4	70.4	19.7	325.1	74.4	16.25	340.9	76.2	13.6	353.67	77.7	11.78
40°	195.69	51.6	24.46	206.29	53.2	22.92	214.19	54.2	21.41	242.9	57.7	16.1	260.9	59.7	13.04	274.25	61.3	10.9	282.2	62.	9.4
35°	157.01	41.4	19.62	166.35	42.9	18.48	172.3	43.6	17.23	195.81	46.5	13.05	210.6	48.2	10.53	221.19	49.6	8.8	431.2	50.8	7.7
30°	127.4	33.6	15.92	133.78	34.5	14.86	138.6	35.	13.86	157.07	37.3	10.47	169.1	38.7	8.45	178.06	39.8	7.1	182.9	40.2	6.09
25°	100.5	26.5	12.56	105.1	27.2	11.6	109.4	27.7	10.94	123.8	29.4	8.2	133.29	30.5	6.66	139.1	31.1	5.5	144.7	31.8	4.7

DOUBLE LOCKS—Continued.

Angles of slopes.	Ratio. 8.			Ratio. 9.			Ratio. 10.			Ratio. 15.			Ratio. 20.			Ratio. 25.			Ratio. 30.		
	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.
20°	76.9	20.3	9.6	80.65	20.8	8.96	83.38	21.1	8.33	92.6	22.	6.17	101.8	23.3	5.09	107.9	23.9	4.3	111.5	24.5	3.71
15°	55.7	14.7	6.96	58.1	15.	6.45	60.46	15.3	6.04	68.6	16.3	4.5	73.8	16.9	3.69	77.4	17.3	3.09	81.4	17.9	2.7
10°	36.02	9.5	4.50	37.6	9.7	4.17	39.1	9.9	3.91	44.2	10.5	2.9	44.3	11.	2.21	50.1	11.2	2.	52.3	11.5	1.7
5°	17.8	4.7	2.22	18.6	4.8	2.06	19.7	5.	1.97	22.3	5.3	1.48	23.6	5.4	1.18	25.05	5.6	1.	26.4	5.8	0.88
Value of Y in feet.	102.4			104.7			106.7			113.7			118.			120.8			122.9		

ESTIMATE of the descent of Lewiston ridge, by double locks, from crest of ridge near Fort George.

Section.	Side slope.	Ratio.	Length of section.	Excavation.	Embankment.	Masonry for recesses, gates, mitre sills, &c.	Masonry for sustaining walls.	Incidental.	Price.	Amount.	Total.
			Feet.	Cubic y'ds.		Cubic yards.					
Marked by the ordinates numbered 3 and 4 upon profile line No. 1.				6,441.40	–	- - -	- - -	–	$0 80	$5,153 12	
							3,586.10	–	4 98	17,858 77	
						224	- - -	–	14 24	3,189 76	
	25°	6.2	70	–	–	Lock gates per run	ning foot of lockage	–	7 05	525 00	
						Estimate for basin	- - -	–	–	62,600 24	
										89,326 89	
							Contingencies	10 per cent.	–	8,932 68	
											$98,259 57
No. 4 to No. 8.				43,157.38	–	- - -	- - -	–	80	34,525 90	
							24,026.87	–	4 98	119,653 81	
						1,500.8	- - -	–	14 02	21,311 36	
	25°	6.2	469	–	–	Lock gates per run	ning foot of lockage	–	7 05	3,517 50	
										179,008 57	
							Contingencies	10 per cent.	–	17,900 85	
											196,909 42
No. 8 to No. 11.				56,902.5	–	- - -	- - -	–	82	46,660 05	
							24,020.55	–	4 98	119,622 09	
						1,296	- - -	–	14 02	18,403 20	
	32° 30′	6.	405	–	–	Lock gates per run	ning foot of lockage	–	7 05	3,037 50	
										187,722 84	
							Contingencies	10 per cent.	–	18,772 28	
											206,495 12

ESTIMATE—Continued.

Section.	Side slope.	Ratio.	Length of section.	Excavation.	Embankment.	Masonry for recesses, gates, mitre sills, &c.	Masonry for sustaining walls.	Incidental.	Price.	Amount.	Total.
			Feet.	Cubic y'ds.		Cubic yards.					
				31,977.12	–	- - -	- - -	–	$0 75	$23,882 84	
							16,628.64	–	4 98	82,810 42	
						1,075 20	- - -	–	14 02	15,267 84	
						Lock gates per run	ning foot of lockage	–	7 05	2,520 00	
						Estimate for basin	- - -	–	–	62,600 24	
No. 11 to No. 13.	26°	6.5	336	–	–					187,081 34	
							Contingencies	10 per cent.	–	18,708 13	
											$205,789 47
				56,613.7	–	- - -	- - -	–	83	46,989 37	
							38,656.9	–	4 98	192,511 36	
						2,604.8	- - -	–	14 02	36,988 16	
						Lock gates per run	ning foot, &c.	–	7 05	6,105 00	
No. 13 to No. 18.	22°	6.	814	–	–					282,593 89	
							Contingencies	10 per cent.	–	28,259 38	
											310,853 27
				43,801.5	–	- - -	- - -	–	85	37,231 27	
							24,385.48	–	4 98	121,439 79	
					1,523.2	- - -	- - -	–	14 02	21,629 44	
						Lock gates per run	ning foot, &c.	–	7 05	3,570 00	
No. 18 to No. 20.	24°	5.8	476	–	–					183,870 50	
							Contingencies	10 per cent.	–	18,387 05	
											202,257 55

No. 20 to No. 23.				32,338.2	–	- - -	- - -	–	75	24,253 65	
							20,861.6	–	5 00	104,308 00	
						1,424	- - -	–	14 02	20,220 80	
						Lock gates per running foot, &c.	-	–	7 05	3,337 50	
	20°	6.5	445	–	–	Estimate for basin	- - -	–	–	62,600 24	
										214,720 19	
							Contingencies	10 per cent.	–	21,472 01	
											236,192 20
No. 23 to No. 27.				33,092.1	1	- - -	- - -	–	25	8,273 02	
							17,035.2	–	5 00	85,186 00	
						2,390.4	- - -	–	14 02	33,943 68	
	10°	20.	447	–	–	Lock gates per running foot, &c.	-	–	7 05	5,602 50	
										133,005 20	
							Contingencies	10 per cent.	–	13,300 52	
											146,305 72
No. 27 to No. 28.				15,062.	–	- - -	- - -	–	25	3,765 50	
							12,957.4	–	5 00	64,787 00	
						1,088	- - -	–	14 02	15,449 60	
						Lock gates per running foot, &c.	-	–	7 05	2,550 00	
	10°	20.	340	–	–	Extra gates -	- - -	–	7 05	1,500 00	
						Estimate for basin	- - -	–	–	62,600 24	
										150,652 34	
							Contingencies	10 per cent.	–	15,065 23	
	At this	point	the line	enters the artificial harbor.							
											165,717 57
From No. 63 to No. 68.						Estimate for dam	- - -	–	–	24,190 00	
				142,520.	–	- - -	- - -	–	25	35,630 00	
							57,386	–	5 50	315,623 00	
	20°	20.	1,400	–	–	4,480	- - -	–	14 05	64,960 00	
						Lock gates per running foot, &c.	-	–	7 05	10,500 00	
										450,903 00	
							Contingencies	10 per cent.	–	45,090 30	
											495,993 30

ESTIMATE—Continued.

Section.	Section.	Ratio.	Length of section.	Excavation.	Embankment.	Masonry for recesses, gates, mitre sills, &c.	Masonry for sustaining walls.	Incidental.	Price.	Amount.	Total.
			Feet.	Cubic y'ds.		Cubic yards.					
From No. 68 to debouch.	Nearly perpendicular.			181,481	–	– – –	– – –	–	$0 70	$127,036 70	
							35,900	–	5 50	197,450 00	
							3,590	–	5 50	19,745 00	
						3,200	– – –	–	14 05	46,400 00	
			1,000	–	–	Lock gates per running foot, &c.	–	–	7 05	7,500 00	
						Extra gates –	– – –	–	7 05	700 00	
						Coffer dam –	– – –	–	–	10,000 00	
						Estimate for two basins	– –	–	–	125,200 48	
										634,032 18	
							Contingencies	10 per cent.	–	63,403 21	
											$587,435 39
Total amount of lockage – – – – –						– – –	– – –	– – –	– –	– –	2,852,208 58
Cost of canal from Porter's store to crest of Lewiston ridge						– – –	– – –	– – –	– –	– –	758,387 63
Total amount from Porter's store-house to Lewiston by double locks						– –	– – –	– – –	– –	– –	$3,610,596 21

Having thus estimated for the descent of the ridge by a system of double consecutive locks, which we regard as the best modification by reference to the great facility it would afford to the passage of vessels, I will now advert to that involving the supposition of a single line of locks, having intermediate basins at such points as circumstances of ground rendered adaptable.

But, in order to render more effective the comparison between them, I must premise that the location of the two lines in the whole development are similar, both in regard to length and lockage, and that from Porter's store-house to Fort Grey the expense is common between them.

The annexed table is similar to that in reference to double locks, only having its elements modified to suit the required conditions.

SINGLE LOCKS.

Formula $Y = \sqrt{(R-1)\,h + 2a \times Rh} - Rh$ a = 73.7 feet.   R = ratio.   h = 19.7 feet.

Angles of the slopes.	Ratio 1.			Ratio 2.			Ratio 3.			Ratio 4.			Ratio 5.			Ratio 6.			Ratio 7.		
	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.
55°	43.57	34.5	43.57	64.7	41.9	32.35	78.5	46.2	26.1	88.74	49.2	22.18	95.95	51.1	19.19	100.92	52.2	16.82	106.04	53.8	15.2
50°	34.22	27.1	34.22	50.65	32.8	25.32	61.37	36.1	20.45	69.44	38.5	17.36	74.75	39.8	14.95	79.46	41.1	13.24	83.26	42.1	11.89
45°	27.15	21.5	27.15	40.46	26.2	20.23	48.96	28.8	16.32	55.19	30.6	13.79	59.71	31.8	11.94	63.22	32.7	10.53	66.25	33.5	9.46
40°	21.97	17.4	21.97	32.58	21.1	16.29	39.4	23.2	13.1	44.55	24.7	11.13	48.25	25.7	9.65	51.2	26.5	8.5	53.59	27.1	7.65
35°	17.6	14	17.6	26.2	17.	13.1	31.79	18.7	10.59	36.	20.	9.	39.05	20.8	7.81	41.3	21.4	6.8	43.11	21.8	6.15
30°	14.14	11.2	14.14	20.23	13.1	10.11	25.5	15.	8.5	29.4	16.1	7.35	31.35	16.7	6.27	33.06	17.1	5.51	34.61	17.5	4.94

25°	11.24	8.9	11.24	16.5	10.7	8.25	20.06	11.8	6.68	22.72	12.6	5.68	24.59	13.1	49.18	26.1	13.5	4.3	27.29	13.8	3.89
20°	8.56	6.8	8.56	13.81	8.3	6.4	15.3	9.	5.1	17.49	9.7	4.37	18.7	10	3.74	19.91	10.3	3.32	20.76	10.5	2.96
15°	6.18	4.9	6.18	9.2	6.	4.6	11.22	6.6	3.74	12.6	7.	3.15	13.7	7.3	2.74	14.5	7.5	2.4	15.22	7.7	2.17
10°	4.04	3.2	4.04	5.86	3.8	2.93	7.14	4.2	2.38	8.12	4.5	2.03	8.82	4.7	1.76	9.28	4.8	1.54	9.69	4.9	1.38
5°	1.93	1.55	1.93	2.62	1.7	1.31	3.57	2.1	1.19	3.96	2.2	99	4.31	2.3	86	4.54	2.35	.7757	4.74	2.4	.67
Value of Y	34.1			41.7			45.9			48.7			50.7			52.2			53.4		

SINGLE LOCKS—Continued.

Angles of the slopes.	Ratio 8.			Ratio 9.			Ratio 10.			Ratio 15.			Ratio 20.			Ratio 25.			Ratio 30.		
	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of excavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.	Variable mass of exeavation in cubic yards.	Mean ordinate.	Variable mass of masonry in cubic yards.
55°	112.23	55.3	14.02	114.08	55.8	12.67	116.97	56.5	11.697	126.09	58.6	8.6	131.5	59.9	6.575	134.66	60.5	5.38	137.58	61.2	4.586
50°	88.08	43.4	11.01	89.13	43.6	9.9	91.71	44.3	9.171	99.2	46.1	6.6	103.2	47.	5.16	105.28	47.3	4.21	107.68	47.9	3.589
45°	70.02	34.5	8.75	70.94	34.7	7.88	73.49	35.5	7.349	78.75	36.6	5.25	81.92	37.3	4.096	83.69	37.6	3.34	85.65	38.1	2.855
40°	56.42	27.8	7.05	59.04	27.98	6.56	59.	28.5	5.9	63.47	29.5	4.23	65.66	29.9	3.283	67.44	30.3	2.69	68.79	30.6	2.293
35°	45.66	22.5	5.7	56.2	22.68	6.2	47.6	23.	4.76	51.21	23.8	3.41	53.87	24.3	2.668	54.53	24.5	2.18	55.75	24.8	1.858
30°	36.5	18	4.5	37.106	18.15	3.123	38.09	18.4	3.809	41.1	19.1	2.6	43.7	19.9	2.18	43.85	19.7	1.75	44.9	20	1.49
25°	28.82	14.2	3.6	29.33	14.35	3.26	30.02	14.5	3.002	32.09	15.1	2.14	33.82	15.4	1.691	34.94	15.7	1.39	35.74	15.9	1.191

20°	21.9	10.8	2.7	22.28	10.9	2.47	22.98	11.1	2.298	24.74	11.5	1.65	25.69	11.7	1.284	26.26	11.8	1.05	26.84	11.94	.894
15°	15.9	7.85	1.9	16.15	7.9	1.79	16.77	8.1	1.677	17.89	8.3	1.19	18.66	8.5	.933	19.03	8.55	.76	19.4	8.63	64.
10°	10.55	5.2	1.31	10.67	5.22	1.18	10.89	5.25	1.089	11.51	5.35	.76	12.07	5.5	.603	12.35	5.55	.49	12.634	5.62	.4211
5°	4.911	2.42	.613	5.008	2.45	.556	5.17	2.5	.517	5.59	2.6	.37	5.97	2.72	.2985	6.23	2.8	.24	6.429	2.86	.2143
Value of Y.	54.8			55.2			55.9			58.1			59.3			60.1			60.7		

ESTIMATE for the descent of Lewiston ridge by single locks.

Section.	Side slope.	Ratio.	Length of section.	Excavation.	Embankment.	Masonry for recesses, gates, mitre sills, &c.	Masonry for sustaining walls.	Incidental.	Price.	Amount.	Total.
Marked by the ordinates numbered three & four upon profile No. 1.	25°	6.2	70	1827.0	-	- -	-	-	$0 80	$1,461 60	
				-	-	112.0	2,072	-	4 98	10,318 56	
							- -	-	14 24	1,594 88	
						- -	Lock gates per running foot,&c		3 75	262 50	
							Estimate for basin	-	-	53,387 40	
										67,024 94	
							Contingencies, 10 per cent.		-	6,702 49	
											$73,727 43
No. 4 to No. 8.	25°	6.2	469	1224.9	-	- -	-	-	80	9,792 72	
				-	-	750.4	13,882.4	-	4 98	69,134 35	
							- -	-	14 02	10,655 68	
							Lock gates per running foot,&c		3 75	1,758 75	
										91,341 50	
							Contingencies, 10 per cent.		-	9,134 15	
											100,475 65
No. 8 to No. 11.	32°	6.0	405	16,726.5	-	- -	-	-	82	13,715 73	
				-	-	648.0	13,000.5	-	4 98	64,742 49	
							- -	-	14 02	9,201 60	
							Lock gates per running foot,&c		3 75	1,518 75	
										89,178 57	
							Contingencies, 10 per cent.		-	8,917 85	
											98,096 42

No. 11 to No. 13.	26°	6.5	336	9,169.44	–	–	–	–	–	75	6,877 05	
							9,807		–	4 98	48,842 84	
				–	–	537.6	–	–	–	14 02	7,633 92	
							Lock gates per running foot, &c			3 75	1,260 00	
							Estimate for basin			–	53,387 40	
											118,001 21	
							Contingencies, 10 per cent.			–	11,800 12	
												129,801 33
No. 13 to No. 18.	22°	6.0	814	16,206.74	–	–	–	–	–	83	13,451 56	
							23,296.68		–	4 98	116,017 56	
				–	–	1,302.	–	–	–	14 02	18,488 40	
							Lock gates per running foot, &c			3 75	3,052 50	
											151,010 02	
							Contingencies, 10 per cent.			–	15,001 00	
												166,111 02
No. 18 to No. 20.	24°	5.8	476	12,423.6	–	–	–	–	–	85	10,560 06	
							14,089.6		–	4 98	70,166 20	
				–	–	761.6	–	–	–	14 02	10,814 72	
							Lock gates per running foot, &c			3 75	1,785 00	
											93,325 98	
							Contingencies, 10 per cent.			–	9,332 59	
												102,658 57
No. 20 to No. 23.	20°	6.5	445	9,238.2	–	–	–	–	–	75	6,928 65	
							12,575.7		–	5 00	62,878 50	
				–	–	712.	–	–	–	14 02	10,110 40	
							Lock gates per running foot, &c			3 75	1,668 75	
							Estimate for basin				53,387 40	
											134,973 70	
							Contingencies, 10 per cent.			–	13,497 37	
												148,471 07

ESTIMATE—Continued.

Section.	Side slope.	Ratio.	Length of section.	Excavation.	Embankment.	Masonry for recesses, gates, mitre sills, &c.	Masonry for sustaining walls.	Incidental.	Price.	Amount.	Total.
No. 23 to No. 27.	10°	20.	747	9,016.3 –	– –	– – 1,195.2	– 19,347.3 – Lock gates per running foot, &c	– – – –	$0 25 5 00 14 02 3 75	$2,254 00 96,736 50 16,971 84 2,801 25	
										118,763 59	
							Contingencies, 10	per cent.	–	11,876 35	
											$130,639 94
No. 27 to No. 29.	10°	20.	340	4,103.8 –	– –	– – 544.	– 8,806.0 – Lock gates per running foot, &c Estimate for basin Extra gates	– – – –	25 5 00 14 02 3 07 – –	1,025 90 44,030 00 7,724 80 1,308 00 53,387 40 350 00	
										107,826 10	
							Contingencies, 10	per cent.	–	10,782 61	
				At this point the line enters the artificial harbor.							118,608 71
No. 63 to No. 68.	20°	20.	1,400	35,966.0 –	– –	– – 2,240	Estimate for dam – 37,240.0 – 1,540 Lock gates per running foot, &c	– – – – –	– 25 5 50 14 05 5 50 3 07	26,256 40 8,991 50 204,820 00 32,480 00 8,470 00 5,180 00	
										286,197 90	
							Contingencies, 10	per cent.	–	28,619 79	
											314,817 69

No. 68 to debouch.	Nearly perpendicular.			103,703	-	-	-	-	-	-	70	72,592 10
								25,300	-	-	5 50	139,150 00
						1,600		-	-	-	14 05	23,200 00
								5,925	-	-	5 50	32,587 50
								Lock gates per running foot, &c			3 75	3,750 00
				5,925	-	-	-	-	-	-	70	4,147 50
								Extra gates	-	-	-	350 00
								Coffer dam	-	-	-	6,000 00
								Estimate for two basins		-	-	106,774 80
												388,551 90
								Contingencies, 10 per cent.			-	38,551 90
												427,103 90
								Total amount of lockage	-	-	-	1,810,511 73
								Cost of canal from Porter's store-house to crest of Lewiston ridge			-	758,387 63
								Total amount from Porters's store house to Lewiston by single locks				$2,568,899 36

Line No. 3, by Manchester village.

This line differs but little in the expense of construction from line No. 1, as shown by the respective estimates. Indeed, we may regard them as modifications of the same line by reference to a general approximation. In making a rigorous location of this line, the element of a decrease in distance is certainly important. But circumstances dependent upon the peculiar features of the location by Manchester village, in reference to its fitness for a manufacturing depot, and the extreme and attractive interest connected with it, thereby rendering it an important thoroughfare, might modify this consideration.

Under any circumstances, we cannot but think that this point, if not embraced by the location, should be united to it by an independent canal. But these are subsequent and minor considerations.

The estimate by this route to Fort Grey is as follows: to which is added the cost of descent by double, as well as that by single locks. The annexed statement shows the details in reference to excavation and wallings.

DETAILED STATEMENT of excavation and walling.

Line No. 3, by Manchester.

Sections.		Mean ordinates.		Area in square feet.		Cubic yards a running foot.			Price a cubic yd.		Price for a quarter of a mile.	Walling.					
		Rock.	Clay.	Rock.	Clay.	Rock.	Clay.					Cubic yds. a quarter of a mile.	Price a cubic yard	Amount.			
1st mile.	1	–	11.33	–	1,242.50	–	46.02		–	.133	8,079.30	2,244.00	1.20	2,692.80	Walling	$4,456 18	
	2	6.70	6.13	719.24	713.33	26.64	26.42		.329	.120	15,752.80	937.20	1.20	1,034.64	Excavation	72,314 40	
	3	14.00	2.33	1,584.00	305.61	58.66	11.32		.329	.107	27,073.20						
	4	8.40	7.76	908.88	958.35	33.66	35.49	157,410.00	.349	.126	21,409.10	607.20	1.20	728.64			$76,770 58
2d mile.	1	3.50	11.00	370.12	1,279.00	13.70	47.37		.356	.133	14,753.60	1,557.60	1.20	1,869.12	Walling	$7,759 36	
	2	3.00	10.00	316.50	1,137.24	11.72	42.12		.343	.133	12,701.00	1,663.20	1.20	1,995.84	Excavation	55,137 70	
	3	2.00	12.16	210.00	1,614.98	7.77	59.81		.356	.140	14,703.50	1,848.00	1.20	1,217.60			
	4	–	15.16	–	1,735.47	–	64.27	281,912.40	–	.153	12,979.60	2,244.00	1.20	2,692.80			62,913 06
3d mile.	1	–	14.83	–	1,692 24	–	62.67		–	.146	12,078.00	2,244.00	1.20	2,692.80	Walling	$8,110 08	
	2	0.75	9.15	78.28	1,000 32	2.89	37.05		.329	.133	7,616.40	2,098.80	1.20	2,518.56	Excavation	46,860 00	
	3	5.60	2.10	598.08	233 31	22.15	8.64		.303	.107	10,005 60	1,148.40	1.20	1,378.08			
	4	5.00	10.30	532.50	1,221 34	19.72	45.23	202,738.80	.356	.133	17,160.00	1,267.20	1.20	1,520.64			54,970 08
4th mile.	1	1.66	29.17	174.01	3,739 41	6.44	138.49		.468	.199	40,524.00	1,914.00	1.30	2,488.20	Walling	$9,855 56	
	2	3.00	33.90	316.50	4,506 70	11.72	166.91		.501	.212	53,988.00	1,663.20	1.30	2,162.16	Excavation	131,504 00	
	3	2.50	23.60	263.12	2,967 08	9.63	109.89		.435	.180	31,548.00	1,760.00	1.30	2,288.00			
	4	–	1.20	–	125 52	–	41.84	603,411.60	–	.100	5,544.00	2,244.00	1.30	2,917.20			141,359 56

DETAILED STATEMENT—Continued.

Sections.	Mean ordinates.		Area in square feet.		Cubic yards a running foot.		Price a cubic yd.		Price for a quarter of a mile.	Walling.					
	Rock.	Clay.	Rock.	Clay.	Rock.	Clay.				Cubic yds. a quarter of a mile.	Price a cubic yard.	Amount.			
5th mile.															
1	-	2.00	-	210.00	-	7.77	-	.106	1,135.20	2,244.00	1.40	3,141.60	Walling	$12,566 40	
2	-	27.50	-	3,422.12	-	126.74	-	.192	31,812.00	2,244.00	1.40	3,141.60	Excavation	109,507 20	
3	-	33.16	-	4,247.52	-	157.31	-	.212	43,560.00	2,244.00	1.40	3,141.60			$122,073 60
4	-	28.33	-	3,549.57	-	131.46	-	.192	33,000.00	2,244.00	1.40	3,141.60			
						558,729.60									
6th mile.															
1	-	22.50	-	2,725.12	-	100.93	-	.172	22,572.00	2,244.00	1.30	2,917.20	Walling	$9,815 52	
2	1.50	17.33	157.12	2,066.40	5.82	76.53	.389	.159	19,140.00	1,953.60	1.30	2,539.68	Excavation	69,300 00	
3	2.83	11.90	298.31	1,263.53	11.04	46.79	.349	.133	13,068.00	1,689.60	1.30	2,196.48			79,115 52
4	3.00	11.44	316.50	1,324.79	11.72	49.06	.356	.139	14,520.00	1,663.20	1.30	2,162.16			
					37,725.60	360,769.20									
7th mile.															
1	2.75	5.25	289.76	574.19	10.73	21.26	.316	.120	7,788.00	1,702.80	1.20	2,043.36	Walling	$8,252 64	
2	3.00	16.36	316.50	1,978.66	11.72	73.28	.389	.153	20,460.00	1,663.20	1.20	1,995.84	Excavation	41,976 00	
3	3.00	5.90	316.50	648.70	11.72	24.02	.316	.120	8,712.00	1,663.20	1.20	1,995.84			50,228 64
4	2.00	3.33	210.00	358.50	7.77	13.27	.296	.113	5,016.00	1,848.00	1.20	2,217.60			
					53,360.80	174,015.60									
8th mile.															
1	2.00	15.60	210.00	1,848.38	7.77	68.45	.382	.153	17,424.00	1,848.00	1.20	2,217.60	Walling	$5,879 64	
2	2.00	23.50	210.00	2,935.00	7.77	108.70	.428	.179	30,228.00	1,848.00	1.20	2,217.60	Excavation	101,772 00	
3	5.33	15.83	568.50	1,971.88	21.55	73.03	.389	.153	25,476.00	1,201.20	1.20	1,444.44			107,651 61
4	12.00	7.33	1,325.99	965.07	49.11	35.74	.356	.126	28,644.00						
					113,784.60	377,414.40									
					503,474.46	2,716,401.60				53,741.60				Total	$695,082 68

Vide preceding statement, from which the amounts are brought over.

Line No. 3, by Manchester.	Cost of 1st mile, line No. 3.	Dolls. cts.	Dolls. cts.
1st mile.			
Cleared ground, with a few scattering trees. Cross Gill creek. Culvert for this object enters amount estimated for contingencies. Draining will be requisite to a considerable amount.	Excavation - -	72,314 40	
	Walling - -	4,456 18	
	Grubbing and clearing	1,500 00	
	Contingencies -	7,827 05	
			86,097 63
2d mile.			
Cleared ground; grubbing light; some draining will be requisite.	Excavation - -	55,137 70	
	Walling - -	7,775 36	
	Grubbing and clearing	1,000 00	
	Contingencies -	6,391 30	
			70,304 36
3d *mile.*			
Ground generally cleared during the first part; last portion for about 1,200 feet through woods; grubbing and clearing requisite.	Excavation - -	46,860 00	
	Walling - -	8,110 00	
	Grubbing and clearing	1,500 00	
	Contingencies -	5,647 00	
4th mile.			62,117 00
Heavily timbered for the first half mile, the other portion cleared; grubbing to a considerable amount.	Excavation - -	131,504 00	
	Walling - -	9,855 56	
	Grubbing and clearing	1,500 00	
	Contingencies -	14,285 95	
5th mile.			157,145 51
Cross Niagara and Lewiston road; last portion of this mile through woods.	Excavation - -	109,507 20	
	Walling - -	12,566 40	
	Grubbing and clearing	1,500 00	
	Contingencies -	12,357 36	
6th mile.			135,930 96
Near the beginning of this mile, this line becomes in common with line No. 1, and has been already referred to.	Excavation - -	69,300 00	
	Walling - -	9,815 52	
	Grubbing and clearing	500 00	
	Contingencies -	7,961 55	
7th mile.			87,577 07
In common with line No. 1, and has already been referred to.	Excavation - -	41,976 00	
	Walling - -	8,252 64	
	Grubbing and clearing	1,000 00	
	Contingencies -	5,122 86	
8th mile.			56,351 50
In common with line No. 1, and has been already referred to.	Excavation - -	101,772 00	
	Walling - -	5,879 64	
	Grubbing and clearing	500 00	
	Contingencies -	10,815 16	
			118,966 80
Cost of construction to Fort Grey - - - - -		-	774,490 83
Cost of descent, by single locks, from Fort Grey to Queenstown Ferry		-	1,810,511 73
Cost of guard and regulating lock at Porter's store-house - -		-	56,958 64
Total cost by single locks - - - - -		-	2,641,961 20
Cost of construction to Fort Grey - - - - -		-	774,490 83
Cost of descent, by double locks, from Fort Grey to Queenstown Ferry		-	2,852,208 58
Cost of guard and regulating lock at Porter's store-house - -		-	56,958 64
Total cost of double locks, via Manchester village -		-	3,683,658 05

I have now given line No. 1, the estimate and plan for the shortest, cheapest, and in a commercial point of view, the best route for our proposed canal. But another consideration is involved in this project, namely, its military relations, by reference to its contiguity to the shores of a foreign power.

It is seen by the projected plan, line No. 1, that it approaches in a great portion of its development to the frontier of Upper Canada, and that it is in this part clearly within the range of howitzer and mortar batteries, planted on the opposite shore of the Niagara river, and likewise entirely under the influence of their power of annoyance at its outlet. And this circumstance has been alleged against the expediency of any location terminating at Lewiston. In order to remove any objection which indeed is valid, by reference to the military advantages that are described to the undertaking, I determined to examine a route by which the inconveniences referred to might be avoided.

A line of levels was accordingly carried up the valley of Gill creek, to a depression which occurs in the Lewiston ridge at the head of Fish creek, and thence descending the ridge, following the valley of Four-mile creek, to its termination on Lake Ontario, and conforming in general direction to a right line between its two extremities.

This route fulfils the condition required. It is throughout its development entirely without the range of annoyance from the opposite shore of Niagara river, and terminates on the lake in deep water.

It must be remarked, in regard to this location, that it exacts very deep cutting in rock for a distance of 3½ miles, but that in other respects the difficulties to be surmounted are less than upon any other route, and particularly in that part which relates to the descent of the ridge. The idea also of the expense in excavation, should be neutralized by the reflection, that the rock taken out would be of essential value for the construction of the harbor, locks, walls, &c.

It is probable that the whole amount of stone taken from the deep cut would be required for these and a variety of contingent purposes, but more particularly for the construction of a capacious and efficient harbor at the debouch of the project.

For such object, the stone would be required from some point or other, and from none could it be procured at so cheap a rate as from the excavation in question.

The harbor would be the last object of completion, and the stone conveniently deposited on the side of the deep cut, would be brought down by the boats through the canal. By means of this abundant supply of materials, the wharves might be carried out to a depth of 14 or 15 feet at little expense, so as to avoid inconvenience from alluvial deposites. We have moreover a sufficient resource against this evil, in the command of water, which might be obtained by pipes conducted from the contiguous elevations to any extent that may be required, in conjunction with sluice gates, &c. But we think such auxiliaries would be unnecessary, with the facilities we possess for conveying piers into deep water. Our plan embraces the supposition of a harbor possessing a circuit of one mile, with piers elevated from 7 to 10 feet above the surface of the water, and 30 feet cross section. It is exhibited on map No. 1.

The details of excavation and walling to the crest of the ridge, are embraced in the annexed statement, followed by a general estimate of cost for the whole line, No. 2, inclusive of harbor at the mouth of Four-mile creek.

DETAILED STATEMENT of excavation and walling.

Line No. 2, from Porter's store-house to beginning of descent of ridge.

Sections.		Mean ordinates.		Area in square feet.		Cubic contents, cubic yards, running foot.		Price of excavation a cubic yard.		Price for a quarter of a mile.	Walling.					
		Rock.	Clay.	Rock.	Clay.	Rock.	Clay.	Rock.	Clay.	Amount.	Cub. yds. a qr. of a mile.	Price a cub. yd.	Amount.			
1st mile.	1	–	13.15	–	1475.2225	–	54.6378	–	.1396	10,097 07	2,248.8	1.20	2,698.56	Walling	$9,832 20	
	2	–	14.20	–	1613.6650	–	59.7650	–	.1462	11,827 20	2,248.8	1.20	2,698.56	Excavat'n	59,835 07	
	3	–	15.00	–	1720.625	–	63.7260	–	.1492	12,619 20	2,248.8	1.20	2,698.56			$69,667 27
	4	4.10	13.90	408.405	1698.32	15.497	62.900	.63	.1452	25,291 60	1,447.1	1.20	1,736.52			
2d mile.	1	5.50	15.50	565.125	1976.5	20.931	73.203	.64	.1500	32,181.60	1,173.3	1.20	1,407.96	Walling	$9,503 64	
	2	–	19.88	–	2400.7994	–	88.9185	–	.1650	19,364.40	2,248.8	1.20	2,698.56	Excavat'n	108,834 00	
	3	–	25.90	–	3305.485	–	122.4248	–	.1850	29,898.00	2,248.8	1.20	2,698.56			118,337 64
	4	–	24.66	–	3113.2106	–	115.304	–	.1800	27,390.00	2,248.0	1.20	2,698.56			
3d mile.*	1	1.40	23.82	140.98	3053.0834	5.221	113.0771	.63	.1790	31,240.88	1,975.1	1.20	2,370.12	Walling	$2,370 12	
	2	12.00	12.47	673.925	974.7799	24.9601	36.1028	.66	.1400	28,419.60	–	–	–	Excavat'n	147,684 00	
	3	18.60	4.90	1087.857	339.276	40.291	12.5857	.68	.1160	38,161.20	–	–	–			150,054 12
	4	23.10	3.40	1427.837	250.036	52.8828	9.2606	.695	.11	49,862.40	–	–	–			
h mile.†	1	21.60	5.95	1302.675	425.1275	48.247	15.7454	.69	.119	46,437.60	–	–	–	Excavation	- -	205,590 00
	2	21.30	9.40	1283.025	704.06	47.519	26.076	.69	.133	47,744.40	–	–	–			
	3	21.00	10.90	1263.375	832.76	46.791	30.843	.69	.136	48,325.20	–	–	–			
4	4	27.80	8.10	1708.775	596.16	63.288	22.08	.71	.126	63,082.80	–	–	–			

5th mile.	1	35.50	12.80	2213.125	1002.24	81.967	37.12	.74	.140	88,242.00	–	–	–	Excavation - -	412,876 20
	2	41.20	12.00	2586.475	930.00	95.799	34.44	.75	.139	104,088.60	–	–	–		
	3	43.90	10.40	2763.325	789.36	102.345	29.232	.765	.135	108,556.80	–	–	–		
	4	45.20	11.40	2848.475	875.66	104.499	32.466	.77	.135	111,988.80	–	–	–		
6th mile.	1	49.10	11.40	3103.92	876.66	114.960	32.466	.78	.135	124,146.00	–	–	–	Excavation - -	498,247 20
	2	53.60	10.50	3398.675	798.09	125.87	29.55	.80	.133	137,979.60	–	–	–		
	3	53.55	10.55	3395.7	801.8	125.75	29.7	.79	.133	136,237.20	–	–	–		
	4	42.50	1.80	2671.6	121.14	98.9490	4.486	.76	.106	99,884.40	–	–	–		
7th mile.	1	35.70	8.10	2126.22	596.28	78.749	22.08	.74	.126	80,711.40	–	–	–	Excavation - -	313,334 40
	2	43.20	10.30	2717.47	980.74	100.647	36.32	.76	.133	107,197.20	–	–	–		
	3	49.90	9.00	3156.325	678.86	116.900	25.14	.78.5	.130	125,425.80	–	–	–		
															1,768,106 83

Estimate for a basin at every half mile, commencing with the third mile, (and being 400 feet in length and 50 feet in breadth,) and ending with the seventh mile.

Rock excavation - - - 250,369 02 cubic yards.
Clay do. - - - 61,566 10 do. do.

Cost - - - - - $184,999 47 — Cost of nine basins - 184,999 47

Total amount - - $1,953,106 30

* The breadth of the canal at the water surface is supposed to be reduced to *sixty feet* at the commencement of this (third) mile.
† Rock is supposed to be excavated by a perpendicular cut from the commencement of this (fourth) mile to the end of the cutting.

Line No. 2, from Porter's store-house to Lake Ontario.

1st mile. First part cleared. The next heavily timbered. Line crosses Gill creek. Culvert for this object enters estimate for contingencies.	*1st mile.*		
	Excavation and embankment -	$59,835 07	
	Walling - - - -	9,832 20	
	Grubbing and clearing - -	1,500 00	
	Contingencies, 10 per cent. -	7,116 72	
			Amount.
			$78,283 99
2d mile. Ground generally heavily timbered. Line crosses the creek. The quantity of water being inconsiderable, it may be received into the canal. Draining requisite.	*2d mile.*		
	Excavation and embankment -	108,834 00	
	Walling - - - -	9,503 64	
	Grubbing and clearing - -	1,500 00	
	Contingencies, 10 per cent. -	11,983 76	
			131,821 40
3d mile. Ground thinly timbered. Crosses Lockport road and Gill creek several times. Draining will be requisite.	*3d mile.*		
	Excavation and embankment -	147,684 00	
	Walling - - - -	2,370 12	
	Grubbing and clearing - -	1,500 00	
	Contingencies, 10 per cent. -	15,155 41	
			166,709 53
4th mile. Ground cleared in portions; the most heavily timbered. Line crosses the creek, and leaves the valley of the creek.	*4th mile.*		
	Excavation and embankment -	205,590 00	
	Walling - - - -		
	Grubbing and clearing - -	1,500 00	
	Contingencies, 10 per cent. -	20,709 00	
			227,799 00
5th mile. Ground heavily timbered throughout. Crosses old Military road at Whitmore's saw-mill. High ground commences.	*5th mile.*		
	Excavation and embankment -	412,876 20	
	Walling - - - -		
	Grubbing and clearing - -	1,500 00	
	Contingencies, 10 per cent. -	41,437 62	
			455,813 82
6th mile. Generally thinly timbered. Intersects Fish creek. Very little water. No culvert necessary. Very high ground, deep cutting in rock.	*6th mile.*		
	Excavation and embankment -	498,247 20	
	Walling - - - -		
	Grubbing and clearing - -	1,500 00	
	Contingencies, 10 per cent. -	49,974 72	
			549,721 92
7th mile. One-third heavily timbered, the remainder cleared. Reach the crest of ridge	*7th mile.*		
	Excavation and embankment -	313,334 40	

the descent from this point is less precipitous than by the line No. 1. Slope about 15°, elevation referred to in detail.					Walling - - - -				
					Grubbing and clearing - -			1,500 00	
					Contingencies, 10 per cent -			31,483 44	
									346,317 84
For nine basins - - - - -					- - - - - -			-	185,000 00
Guard and regulating lock at Porter's store-house -					- - - - - -			-	56,958 64
Estimate for a flight of 16 *locks, from the bottom of canal at depression near head of Fish Creek.*									
Side slope.	Ratio.	Length of section.	Excavation.	Masonry for recesses, mitre sills, &c.	Walling for interior slopes of canal.	Masonry for sustaining walls.	Price.		
			167,616	-	- -	-	$0 70	117,331 20	
						138,816	4 98	691,303 68	
15°	7	3,200	-	10,240	- -	-	14 02	145,408 00	
					Lock gates -	-	7 05	24,000 00	
					Basin - -	-	-	62,600 00	
								1,046,642 88	
					Contingencies, 10 per cent.		-	104,064 28	
									1,144,707 16
For one thousand feet of canal.									
		1,000	40,740	-	- -	-	13	5,296 20	
					1,400	-	1 40	1,960 00	
					Contingencies, 10 per cent.		-	725 62	
									7,981 82
Estimate for four locks terminating at point "C."									
			41,904	-	-	-	70	29,332 80	
						34,704	4 98	172,825 92	
15°	7	800	-	2,560		-	14 02	36,352 00	
					Lock gates -	-	7 05	6,000 00	
					Contingencies, 10 per cent. -		-	24,451 07	268,961 79
					Total amount to point "C." -		-	-	3,620,076 91

Continuation of Line No. 2, from Porter's store-house to the mouth of Four-mile Creek, on Lake Ontario.

		Cubic yards.			
8th mile. Section 2,740 *feet, beginning at point "C."*					
Cleared ground, but little draining will be requisite. Grubbing light.	Excavation and embankment -	80,233.5	cts. 11	$8,825 68	
	Walling - - - -	4,658.0	$1 20	5,589 60	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		400 00	
	Contingencies, 10 per cent. -	–		6,698 42	
					$73,682 70
9th mile. Section 2,780 *feet.*					
In road, both sides heavily timbered; ground swampy; draining will be requisite in some portions of this mile.	Excavation and embankment -	79,092.4	11	8,700 16	
	Walling - - - -	4,726.0	1 20	5,671 20	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		400 00	
	Contingencies, 10 per cent. -	–		6,694 03	
					73,634 39
10th mile. Section 2,460 *feet.*					
In road both sides heavily timbered, with exception of occasional clearings.	Excavation and embankment -	69,988.2	11	7,698 70	
	Walling - - - -	4,182.0	1 20	5,018 40	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		650 00	
	Contingencies, 10 per cent. -	–		6,553 61	
					72,089 71
11th mile. Section 7,800 *feet.*					
In road, occasional clearings on either side of it—the rest heavily timbered.	Excavation and embankment -	221,914.0	11	24,410 54	
	Walling - - - -	13,260.0	1 30	17,238 00	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		1,500 00	
	Contingencies, 10 per cent. -	–		9,531 75	
					104,849 29
12th mile. Section 7,900 *feet.*					
In road, cross Four-mile creek; ground for the most part cleared.	Excavation and embankment -	224,759.1	11	24,723 50	
	Walling - - - -	13,430.0	1 40	18,802 00	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		1,560 00	
	Contingencies, 10 per cent. -	–		9,725 45	
					106,979 95
13th mile. Section 1,390 *feet.*					
In road, occasional clearings on either side, the rest heavily timbered.	Excavation and embankment -	39,539.7	11	4,349 36	
	Walling - - - -	2,363.0	1 50	3,544 50	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		500 00	
	Contingencies, 10 per cent. -	–		6,056 28	
					66,619 14

14th mile. Section 2,810 feet.					
Cleared ground. The line of levels coincides with road - -	Excavation and embankment -	79,932.8	11	8,792 60	
	Walling - - - -	4,777.0	1 50	7,165 50	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		700 00	
	Contingencies, 10 per cent. -	–		6,882 71	
					75,709 81
Section 3,090 feet.					
From the 14th mile to lake: ground for the most part cleared -	Excavation and embankment -	87,897.7	11	9,668 75	
	Walling - - - -	5,253.0	1 50	7,879 50	
	Price of lock 10 feet lift - -	–		52,169 00	
	Grubbing, clearing, and draining	–		850 00	
	Contingencies, 10 per cent. -	–		7,056 72	
					77,623 97
	Price of 34 feet of lockage, [here the line arrives at Lake Ontario]				177,374 60
	Harbor at the mouth of Four-mile creek, and contingencies -				167,783 00
	From Porter's store-house to point "C" - - - -				3,620,076 91
	Total am't of line No. 2, from Porter's store-house to Lake Ontario				$4,616,423 47

Should preparation for the state of war be a paramount consideration in the construction of this work, this location should I think be adopted in its whole extent. But there are considerations which induce me to suggest an arrangement modified upon the two routes; namely: No. 1 and No. 4. I have already adverted to the advantages to be derived to the work, from the possession of a good harbor at its outlet, by reference to commercial purposes, and in time of peace it would be inconvenient to forego that which is offered by the Niagara river, in conjunction with the artificial harbor which I have projected. A circumstance that in its commercial aspect renders the outlet at Lewiston unexceptionable.

The modification I refer to, is to bring the canal down to the foot of the ridge by line No. 4. This much might be regarded as a war preparation, as all the great difficulties in regard to the project in that point of view, would be by that means already achieved and prepared for the contingency alluded to. From this point the distance to the termination of the canal on Lake Ontario, by the valley of the Four-mile creek, would be common place, and comparatively unexpensive, as the slope is perfectly gradual to the edge of the lake. This portion might be left until the policy of Government should think it expedient to prosecute the whole line to its completion.

In the mean time my plan proposes to take the water from the point of the descending locks, where its surface shall be comprised in the same horizontal plane as the surface of the artificial harbor at Lewiston. This agrees nearly with the intersection of our profile with the ground at the foot of the second berm, and the canal would therefore be carried along the termination of this slope, without lockage, in the best possible ground for such purpose, and by a cut of no consideration across the main street at Lewiston, debouch into the artificial harbor to be there constructed; and finally, as already described, into the Niagara.

The greater cost of this line is justified as a precautionary measure, and its excess over line No. 1, would belong to that class of governmental expenses.

Viewing this project in its remote political bearing, we cannot refrain from the expression of our favorable opinion in regard to its adoption. The more particularly as we conceive that the short distance comprised between the point of divergency from the direct line to the lake, and its outlet at Lewiston, would shortly pay for itself, by the commercial advantages that we may justly ascribe to it.

The estimate for this modification is as follows:

From Porter's store-house to Niagara river.

Line No. 2, modified and terminating at Lewiston, passing through the artificial harbor.

From Porter's store-house to point "C" - - -	$3,620,076 91	
		$3,620,076 91
From point "C" to the artificial harbor, 5,100 feet.		
Excavation, 207,774 cubic yards, at 13 cents - -	27,010 62	
Walling the sides of the canal, 71,400 cubic yards, at $1 40	9,996 00	
Grubbing and clearing - - - - -	700 00	
Contingencies 10 per cent. - - - - -	3,770 66	
		41,477 28
From artificial harbor to Niagara river.		
For 119.5 feet of lockage - - - - -	1,083,428 69	
		1,083,428 69
Total amount - -	- -	$4,744,982 88

Cayuga Creek.

At the instanee of gentlemen interested in the project, I was induced to order a line of levels to be run from the mouth of the Cayuga creek, ascending its valley towards a depression that exists at its head near the town of Pekin.

This line is exhibited in the general map of the survey.

The elevation of the ridge, at its lowest point, was found to be as great as 390 feet above the level of Lake Ontario. This circumstance, in conjunction with great length, would render the route extremely expensive, without compensating by any advantage whatever over the other and cheaper routes surveyed.

In the course of our survey several modifications were thought of, and data in reference thereto procured; but I have only thought it necessary to exhibit details where results have made them interesting.

Reconnoisance of Eighteen-mile creek, map No. 3, profile No. 5.

I have now to advert to a proposed route by the valley of the Eighteen-mile creek, and shall premise by a transcript from a report which I had the honor to submit to the bureau a few days since, in answer to a call from a member of the United States Legislature, in regard to the harbor at its mouth. This document comprises all that relates to the harbor at the mouth of Eighteen-mile creek, by reference to its capacity to admit vessels of the draft required, for the project of a ship canal.

It likewise explains the auspices under which the survey was executed. It is in effect as follows:

In obedience to your instructions, to prepare immediately such information as I might have in my possession, in regard to the harbor at the mouth of the Eighteen-mile creek, and furnish it to the bureau, I have the honor to report:

That at the termination of my survey last summer in regard to a ship canal around the Falls of Niagara, as per instruction of the Department, I was called upon by a committee of gentlemen from Lockport, requesting me to make a survey in reference to a similar object, from the mouth of Eighteen-mile creek to the outlet of the Tonnewanta, on the Niagara river. The expenses of the survey to devolve upon those interested.

Although it was not in my power, consistently with my defined duties for the season, to attend to the details of this survey, I knew it was the wish of the Department to render every facility of the character required I determined to make a reconnoissance of the project referred to, previously to leaving this section of the country to superintend the completion of plans, drawings, &c. in regard to a survey of which I had charge on Lake Champlain.

This being effected, I ordered Lieutenant Drayton, assisted by Lieutenant Reed, to make a cursory survey of the ground between the mouth of Tonnewanta creek and the mouth of Eighteen-mile creek, directing their attention, however, more particularly to the data necessary to ascertain its properties in regard to a commercial outlet.

This duty was performed with great ability by these officers, and the accompanying maps will show that every fact of importance was duly regarded in the course of their examination.

It appears that there is only a depth varying from three to four feet at the mouth of the creek; and that to effect a channel of ten feet would require an excavation in rock, between six and seven feet in depth, for a distance of 1,359 feet.

Within this bar, which circumscribes the outlet, there is a depth of ten feet to a distance 1,500 feet above the bridge, at the mouth of the creek; but the average breadth of this channel does not exceed 90 feet. And the whole breadth, upon which a harbor by excavation could be made available, would be an average of 625 feet. This area, we suppose, would form a harbor sufficiently spacious for the amount of commerce to be reasonably calculated upon at this point.

The plan and expense of constructing a harbor there of this capacity would be as follows:

We would give to the entrance, between two jettees, a breadth of 100 feet and a depth of 10 feet. The jettees would therefore be carried out to a depth of ten feet. They would be constructed in crib work, and filled in with stone taken out of the excavation; and would be elevated at a minimum height of five feet above the surface, by reference to the mass of stone, and 6.9, inclusive of wood work.

The cribs would be founded upon rocks, the shape of their bottom being determined so as to correspond with the surface upon which they are to rest. A light-house will be established at the extremity of the windward jettee. The jettees on their interior extremity will terminate in deep water within the rock bar inclosing the creek. Wharves of the same extent of surface will be carried to the shores on each side of the creek, for the accommodation of trade, as shown in the accompanying map. This, however, is only in the immediate vicinity of the mouth. The same facilities would be indispensable to the extent of the portion of the harbor to which my report refers, in the event of an increase of trade.

The estimate of expense is as follows:

Excavation by dredging in the creek between bridge and a point 1,500 feet above, 168,933, at 25 cents - -	$42,233 00
6338.6 cubic yards of excavation, partly by dredging -	1,267 70
Excavation in rock, inclusive of blasting under water, at $1 25 - - - - - - - -	25,925 00
Wood work of jettee and wharves, estimated - -	14,000 00
Filling in 17,173 cubic yards of stone from excavation -	8,586 00
Contingencies - - - - - -	9,201 17
Total - - . -	$101,212 87

This estimate refers to a distance in ascending the creek of 1,500 feet, but a depth of ten feet, upon an average breadth of 75 feet, can be carried to a distance of 7,000 feet. So that the harbor can at any time be increased, if the increase of trade should demand it.

With regard to the facility for keeping the harbor clear of alluvial deposites, it must be observed, that there is a considerable fall in the Eighteenmile creek, and that if the amount of trade should justify the expense, a sufficient command of water could be procured to guaranty, by means of sluices, the excavated channel from their effects. Otherwise occasional dredging would have to be resorted to.

No item of expense for the construction of wharves is involved in the estimate, as such facilities spring more properly from individual enterprise, in proportion as the exigencies of business become greater."

From the point referred to as the termination of the harbor in the above report, the canal would pursue the channel of the creek, widened for that purpose, to a distance of 2,840 yards above its mouth, after which, for a distance of about four miles, to a point near Adam's saw-mill, lock and dam navigation is projected; and for the sake of economy, we propose a single lock at the termination of each basin, formed as they would be by successive dams of about 12 feet elevation. The high banks now recede from the creek, leaving a valley sufficiently wide, through which the canal would be cut.

The location would be, in this part, obliged to pass at a distance from the creek, without the reach of freshets. The ground is low and swampy, and generally well timbered.

In ascending from the point where the line of levels enters the gorge, below Lockport, shown on the map at the end of the eleventh mile, the navigation by lock and dam would recommence, and by this means we reach a point nearly at the level of water at the foot of the existing locks at Lockport.

The ascent from this would be effected by four consecutive double locks, two of ten and two of eleven feet lift, to reach the present level of Tonnewanta creek, as modified by the dam at its mouth.

From Lockport to the mouth of this creek the canal is supposed to occupy the ground of the Erie canal, this being widened and deepened for that object, to the amount required by the dimensions of our project. From Pendleton village to the termination of the line, on the Niagara river, the bed of the Tonnewanta is made use of. Several obstructions, as shown on the map, being removed, to render it adaptable to the purpose.

In this project, it is to be observed that water for the supply of lockage, &c. would be drawn through the present Erie canal, from the level of Lake Erie.

The descent from the mouth of the Tonnewanta creek into Niagara river would be effected by double locks, the difference of level amounting to 4.4 feet. No excavation would be required at the mouth of the creek.

The distance between the two extremities of this line is 32 miles. The deep cutting in rock between Lockport and Pendleton extends about 3½ miles, and the greatest depth 41 feet from the bottom of the canal. There is about the same distance of deep cutting in clay.

The details are shown on profile No. 5, map No. 3.

The estimate is as follows:

ESTIMATE of the expense of construction of canal by Eighteen-mile and Tonnewanta creeks.

	Cubic yards.	Price.	Dollars. Cents.	Amount.
Cost of harbor at mouth of Eighteen-mile creek -				$101,212 87
Excavation from termination of harbor to the 1st dam -	64,009.2	0.25	16,002 30	
Contingencies - - - - - -			1,600 23	
				17,602 53
Cubic contents of 1st dam - - - - -	1,098.7	5	5,493 50	
Price of lock - - - - - - -			43,819	
Excavation from 1st to 2d dam - - - -	43,162.9	0.70	30,214 03	
Contingencies - - - - - -			8,152 65	
				89,679 18
Cubic contents of 2d dam - - - - -	830.2	5	4,160	
Price of lock - - - - - - -			43,819	
Excavation from 2d to 3d dam - - - -	47,250	0.70	33,075	
Contingencies - - - - - -			8,105 40	
				89,159 40
Cubic contents of 3d dam - - - - -	1,205.4	5	6,027	
Price of lock - - - - - - -			43,819	
Excavation from 3d to 4th dam - - - -	83,611.1	0.70	58,527 77	
Contingencies - - - - - -			10,837 37	
				119,211 14
Cubic contents of 4th dam - - - - -	1,045.4	5	5,227	
Price of lock - - - - - - -			43,819	
Excavation from 4th to 5th dam - - - -	42,000	0.70	29,000	
Contingencies - - - - - -			7,844 60	
				86,290 60
Cubic contents of 5th dam - - - - -		5	5,573 50	
Price of lock - - - - - - -			43,819	

	Cubic yards.	Price.	Dollars. Cents.	Amount.
Excavation from 5th to 6th dam	37,961.6	0.70	26,541 62	
Contingencies			7,593 41	
				$83,527 53
Cubic contents of 6th dam	2,966.7	5	14,833 50	
Price of lock			43,819	
Excavation from 6th to 7th dam			19,055 54	
Contingencies			7,770 80	
				85,478 84
Cubic contents of 7th dam	1,557.4	5	7,787	
Price of lock			43,819	
Excavation from 7th to 8th dam			29,772 16	
Contingencies			8,537 81	
				89,515 97
Cubic contents of 8th dam	1,766.2	5	8,831	
Price of lock			43,819	
Excavation from 8th to 9th dam			56,350	
Contingencies			10,900	
				119,900 0
Cubic contents of 9th dam	2,993.4	5	11,467	
Price of lock			43,819	
Excavation from 9th to 10th dam	59,888.8	0.70	41,922 16	
Contingencies			9,720 81	
				106,928 97
Cubic contents of 10th dam	1,632	5	8,160	
Price of lock			43,819	
Contingencies			5,197	
				57,176 90

Termination of lock and dam					$1,045,683 93
1st section: Excavation (hard clay)	22,718.8	0.13	2,953 44		
1st section: Price of lock			52,169		
1st section: Contingencies			5,512 24		
				$60,634 68	
2d section: Excavation (hard clay)	334,396.6	0.16	53,503 45		
2d section: Price of lock			52,169		
2d section: Contingencies			10,567 24		
				116,239 69	
3d section: Excavation	335,688.8	0.11	36,925 76		
3d section: Price of lock			52,169 3		
3d section: Contingencies			8,909 47		
				98,004 23	
4th section: Excavation (hard clay)	47,187.4		5,480 66		
4th section: Contingencies			548 06		
				6,028 72	
Cubic contents of 11th dam	832	5	4,160		
Price of lock			43,819		
Excavation to 12th dam	13,611.1	0.12	1,633 33		
Contingencies			4,961 23		
				54,573 56	
Cubic contents of 12th dam	565.3	5	2,826 50		
Price of lock			43,819		
Excavation from 12th to 13th dam	5,833.3	0.70	4,083 31		
Contingencies			5,072 80		
				55,801 60	
Cubic contents of 13th dam	325.3	5	1,626 50		

ESTIMATE—Continued.

	Cubic yards.	Price.	Dollars. Cents.	Amount.
Excavation to 14th dam	6,518.4	0.70	4,562 88	
Contingencies			5,500 83	
				$55,509 28
Cubic contents of 14th dam	325.3	5	1,626 80	
Price of lock			43,819	
Excavation to 15th dam	17,731.1	0.70	11,011 77	
Contingencies			5,645 72	
				62,102 99
Cubic contents of 15th dam	325.3	5	1,626 50	
Price of lock			43,819	
Excavation to 16th dam			8,626 24	
Contingencies			5,407 17	
				59,478 91
Cubic contents of 16th dam	325.3	5	1,626 50	
Price of lock			43,819	
Excavation to 17th dam	2,365.7	0.70	16,559 90	
Contingencies			6,260 54	
				68,265 94
Cubic contents of 17th dam	325.3	5	1,626 50	
Price of lock			43,819	
Excavation to 18th dam	5,250	0.70	3,675	
Contingencies			4,912 08	
				54,032 58
Cubic contents of 18th dam	549.3	5.0	2,746 50	
Price of lock			43,819	
Excavation to 19th dam	4,666.6	.70	3,266 55	

Contingencies - - - - - -			4,983 20	
				54,815 25
Cubic contents of 19th dam - - - - -	565.3	5.0	2,826 50	
Price of lock - - - - - - -			43,819	
Excavation to 20th dam - - - - -			16,333 31	
Contingencies - - - - - -			6,297 88	
				69,276 69
Cubic contents of 20th dam - - - - -	1,098.7	5.0	5,493 50	
Price of lock - - - - - - -			43,819	
Excavation to 21st dam - - - - -	12,250	.70	8,575	
Contingencies - - - - - -			5,788	
				63,676 25
Cubic contents of 21st dam - - - - -	869.3	5.0	4,346 50	
Price of lock - - - - - - -			43,819	
Excavation to 22d dam - - - - -	18,861	.70	13,202 70	
Contingencies - - - - - -			6,136 82	
				67,505 02
Cubic contents of 22d dam - - - - -	1,365.3	5.0	6,826 50	
Price of lock - - - - - - -			43,819	
Excavation to 23d dam - - - - -	13,222.2	.70	9,255 54	
Contingencies - - - - - -			5,990 10	
				65,991 14
Cubic contents of 23d dam - - - - -	1,365.3	5.0	6,826 50	
Price of lock - - - - - - -			43,819	
Excavation from 23d to 24th dam - - - -	12,444.4	.70	8,711 08	
Contingencies - - - - - -			5,935 55	
				65,291 13
Cubic contents of 24th dam - - - - -	421.3	5.0	2,106 50	
Price of lock - - - - - - -			43,189	
Excavation from 234 to 236, nearly - - - -	5,833.3	.70	4,083 01	
Cubic contents of 25th dam, near 236 - - -			2,933	

ESTIMATE—Continued.

	Cubic yards.	Price.	Dolls. cts.	Amount.
Contingencies			5,294 18	$58,235 99
Double Locks.				
Excavation	5,333.3	.70	3,733 10	
Price of locks			66,715	
Contingencies			7,044 83	
				77,493 14
Excavation	5,155.5	.70	3,608 85	
Price of locks			66,715	
Contingencies			7,032 38	
				77,356 23
Excavation	10,343.7	.70	7,240 59	
Price of locks			66,715	
Contingencies			7,395 55	
				81,351 14
Excavation	12,711.1	.70	8,897 77	
Price of locks			66,715	
Contingencies			7,661 27	
				83,174 04
Estimate for grubbing and clearing (9 miles)	1,500			2,500,522 06
				13,500
Total amount				2,514,022 06

Continuation of estimate from upper lock at Lockport to Pendleton, at junction of Erie canal and Tonnewanta creek.

	Cubic yards.	Price.	Dolls. cts.	Amount.
Amount brought forward - - -				$2,514,022 06
Section—4,800 *feet.*				
Rock excavation in cubic yards - - - -	536,315.8	.75	402,236 76	
Contingencies, 10 per cent. - - - - -			40,223 67	
Section—4,370 *feet.*				442,460 43
Rock excavation in cubic yards - - - -	552,742.4	.75	414,556 80	
Contingencies, 10 per cent. - - - - -			41,455 68	
Section—3,600 *feet.*				456,012 48
Rock excavation in cubic yards - - - -	495,466.6	.75	374,599 95	
Contingencies, 10 per cent. - - - - -			37,459 99	
Section—8,851 *feet.*				412,059 94
Excavation in cubic yards - - - - -	1,397,832	.23	321,501 36	
Walling in cubic yards - - - - -	14,802.1	1.40	20,723 08	
Contingencies, 10 per cent. - - - - -			34,222 44	
Section—4,880 *feet.*				376,446 88
Rock excavation in cubic yards - - - -	608,697	.75	456,522 75	
Contingencies, 10 per cent. - - - - -			45,652 27	
Section—9,000 *feet.*				502,175 02
Excavation in cubic yards - - - - -	997,370	.21	209,447 70	
Walling in cubic yards - - - - -	15,066	1.40	21,092 40	
Contingencies, 10 per cent. - - - - -			23,054 01	253,594 11
Total - - - - -				$4,956,770 92

Continuation of estimate for deepening channel of Tonnewanta creek, from Pendleton to its mouth.

	Cubic yards.	Price.	Dolls. cts.	Amount.
Amount brought forward - - -				$4,956,770 92
Section—268 *feet.*				
Rock and gravel excavation in cubic yards - - -	1,985.1	1.25	2,461 37	
Contingencies, 10 per cent. - - - - -			246 13	
				2,707 50
Section—1,062 *feet.*				
Gravel excavation in cubic yards - - - -	7,856.6	.40	3,142 64	
Contingencies, 10 per cent. - - - - -			314 26	
				3,456 90
Section—2,697 *feet.*				
Gravel excavation in cubic yards - - - -	19,977.7	.40	7,991 08	
Contingencies, 10 per cent. - - - - -			799 10	
				8,790 18
Lock and dam at the mouth of Tonnewanta creek, estimated at				70,000
				$5,041,725 50

Of the preceding lines, we will assume the five following, as the best basis on which to institute a comparison by reference to their fitness for the proposed project.

	Cost.
Line No. 1.—Shortest route from Porter's store-house to steam-boat wharf, or ferry, at Lewiston, by single locks - - - -	$2,568,899 36
Do. by double locks - - -	3,610,596 21
Line No. 2.—From Porter's store-house, by Gill creek and Four-mile creek, terminating on Lake Ontario - - - - -	$4,616,423 47
Modification of line No. 2, as above, and terminating at Lewiston, passing through artificial harbor	$4,744,982 88
Line No. 5.—By Eighteen-mile creek, Lockport and Tonnewanta creek - - - -	$5,041,725 48

Lengths of lines Nos. 1, 2, 3, and 4, together with their "modifications," included between Porter's store-house and Lewiston, and Porter's store-house and mouth of Four-mile creek.

	Miles.	Feet.
Line No. 1.—From Porter's store-house to Queenstown ferry, by way of Bloody run, Devil's hole, and Fort Grey, descending mountain by double and consecutive locks - - - - -	7	4,040
Line No. 1.—From Porter's store to "steam-boat wharf," at Lewiston, descending mountain by single locks	8	3,660
Line No. 1.—From Porter's store-house to "Queenstown ferry, at Lewiston, descending mountain by single locks, principally - - - - -	8	3,180
Line No. 4.—From Porter's store-house, by "New Manchester," to steam-boat wharf, at Lewiston, following the valley of Fish creek, and descending mountain through depression at Miller's Sulphur spring - - - - - -	9	5,230
Line No. 3.—From Porter's store-house, by New Manchester to steam-boat wharf, at Lewiston, descending the mountain at Fort George - -	10	2,400
Line No. 3.—From Porter's store-house, by same route, but terminating at Lewiston, at Queenstown ferry -	10	1,920
Line No. 2.—From Porter's store-house to mouth of Four-mile creek, following the valleys of Gill and Four-mile creeks, and descending mountain through depression at Miller's Sulphur spring -	14	5,000
Modification of line No. 2; by diverging at C, at foot of second berm, and following it westwardly to D, where it debouches into artificial harbor - -		5,120

COMPARISON OF ROUTES.

The annexed summary of cost, applied to its respective experimental location, in connection with the statement in regard to distances, enables the mind to form, at a glance, the comparison between them by reference to these elements. But in order that a judicious selection may be made, other considerations necessarily become involved in the question, and these, in a great measure, furnish the medium through which their properties are to be adjudged.

As a commercial scheme exclusively, with the most rigorous economy as the governing principle, even to the prejudice of convenience of trade, and barely to effect the object of connection between the lakes, for a large class of vessels, the first plan referred to, in the annexed statement, would, of course, be adopted.

If this scheme, however, involved the idea of an expenditure proportionate to the character of the enterprise, and importance of the results that may be justly ascribed to it, we would without hesitation recommend the second, namely; the descent by double locks; for it is evident that in the first proposition, a great delay would frequently occur in the passage of vessels, an evil that would accumulate with the increase of trade, and result eventually in the necessity of constructing another independent flight of locks; this, by a comparison of estimates, is shown to be inexpedient.

But when the question passes beyond the limit of commercial operations merely, and enters the sphere of political expediency, new considerations are involved, tending, very generally, to embarrass a decision. It was this reflection that induced me to survey the line No. 2, as I have already explained, in presenting the estimate of its expense. In doing so, moreover, I, perhaps, have said all that is necessary, in regard to its advantage over the preceding lines, No. 1, and its modification.

In discussing the merits of the modification to line No. 2, the question is resolved into the following proposition: whether it be desirable to expend an additional million of dollars, as a measure of precaution, to enable the work to reach a point E, (map No. 1,) whence it could easily be conducted, in case it should be deemed advisable, to the lower lake, and be, in its whole development, without the pale of annoyance from an enemy. It is for those who should determine to execute the work, to judge of this expediency.

We would call the attention, however, to the character of permanence and durability that must belong to such a project, and suggest that the future interests of the country are to be, in a measure, dependent upon it, and that it would prove a humiliating and grievous reflection to after times, should the work be suddenly neutralized in its advantages, at the very moment when its facilities ought to be most sensibly useful to the nation.

To develop all the considerations involved in this comparison, would exact more time than I am permitted to devote to it. It is sufficient to show, that a route possessing the property of security from insult, is practicable, and at a reasonable cost to the nation.

But the comparison between the Lockport route, and the one I have just alluded to, may be referred to the common standard of military expediency.

It is seen, by reference to the foregoing statement of costs and lengths of location, that the route by line No. 2, has the advantage in point of econo-

my, to the amount of $296,743 over that by Lockport. We see, likewise, by reference to this statement, and the respective maps accompanying my report, that it possesses the advantage of being a shorter and less embarrassed line of communication.

Its supposed advantages have been predicated upon the belief that it offered a more retired line of communication from foreign aggression; and this is a maxim that ought not to be overlooked; but in the present instance it admits of modification, owing to the peculiar features of topography characterizing the vicinity, to this portion of the line of contact of the two countries.

By reference to the map it will be seen that from Porter's store-house to the end of line No. 2, on Lake Ontario, our shores are precipitous, and offer a difficult barrier in any part to the landing of a hostile force, and that with the precaution growing out, as it were, of the project, should it be executed, as explained in the accompanying memoir, the line would be rendered inaccessible.

We are impressed with the belief that we should avail ourselves of the topography of the frontier, and regarding the Niagara river, from Porter's store-house to Lake Ontario as a natural entrenchment, concentrate our resources there, as furnishing the strongest accessorial advantages to resist invasion, and at the same time enable us promptly to assume the attitude of aggression under auspicious circumstances, and to the achievment of the most important results.

By retiring the line, we abandon, in a measure, our strong ground of resistance, and throw it from beneath the shelter of our military establishment, already constructed at the mouth of the Niagara river, by which the debouch of line No. 2 would be sustained.

It is seen, also, that in comparing the two routes, that one portion of navigation would be common between them, namely, that between Lake Erie and the mouth of Tonnewanta creek, and this portion is unquestionably the most accessible part of the line to a hostile descent from the opposite shore.

In addition to these considerations, the project of line No. 2, supposes an excellent harbor at its termination on Lake Ontario, while that projected at the mouth of the Eighteen-mile creek is comparatively inefficient; observing at the same time, that the rocky bar circumscribing its mouth must ever prove an obstacle to its improvement.

Moreover, the contiguity of the inlet of the Niagara river to the mouth of Four-mile creek, our projected termination, is a great desideratum, as vessels in stress of weather, may run without apprehension for the harbor there, in the assurance that in case of difficulty to effect an entrance, they will be at least in the vicinity of a harbor of easy access, where they may take refuge until more seasonable weather.

It must be noticed, in regard to this subject, that any artificial harbor on this shore of the lake, would be difficult of access in very heavy storms, owing to the danger of concussion against the sides of the piers, an inconvenience I have often noticed at the celebrated artificial harbor of Ramsgate, in Kent, England.

Superadded to the objections already stated, in regard to the route by Lockport, there is one important circumstance in the inconvenience and delay that the navigation on the present Erie canal would be subjected to, and we think that the loss sustained by it, would scarcely be compensated

by the diminution in the expense of our estimate, by the deduction we have made, in the assumption that the excavation for our present project would be diminished by the amount of that already executed for the Erie canal.

In the supposition of an entire new location, the estimate would, of course, be greatly augmented, and the difference of cost in favor of line No. 2, proportionably increased.

It is to be noticed in the line No. 2, that a portion of its development has a diminished breadth. This advantage, for the economy of excavation, could not be adopted on the Lockport route. In the first case, business would be divided between the two canals, but in the other it would necessarily be concentrated, and embarrass the operations of trade, unless it should possess a breadth equal to that we have projected.

In order to fully prepare the undertaking for the contingency of a rupture with our Canada neighbors, it would be necessary to pass the rapids of Black Rock, by a short cut and a few feet of lockage on the American shore. As the channel of the Niagara river is, in this part, on the Canada side. This modification applies, equally, to either route compared, and may remain as an item for future consideration, the expense being regarded as inconsiderable.

A plan indeed has occurred to me by which the whole of this accessible portion, between Buffalo and the mouth of Tonnewanta creek, might be somewhat more retired and more easily protected. The expense of this work would be, of course, somewhat greater. Let the canal commence at Buffalo, and carry the level of the lake, as nearly as may be admissible, along the valley of the Niagara river, as far retired from its margin as the nature of the topography will permit, to the mouth of Gill creek, ascending the valley of this stream to the head of Fish creek, as per line No. 2, and thence descending to Lake Ontario. By this means we save a very considerable prism of rock excavation, and thus compensate, in some measure, for the greater length of the canal. This prism would be proportionate to the elevation that Lake Erie may possess over the level of Niagara river, at our point of beginning, near Porter's store-house.

The plans, maps, and profiles, accompanying the present report, are as follows:

General topograpical map, Lewiston line—No. 1.

Plan of location for descent of ridge, artificial harbor, and section of lock—No. 2.

General topographical map, Lockport line—No. 3.

Map of harbor at mouth of Eighteen-mile creek—No. 4.

Profile line, No. 1.

Profile line, No. 2.

Profile line, No. 3.

Profile line, No. 4.

Profile line, No. 5.

These comprise all the rigorous data obtained in the course of our examination; and will, I hope, when collated with my report, satisfactorily illustrate the subject under consideration.

In the course of my duty I have been assisted in the field, and in the various incidental calculations connected with the survey, by Lieutenant T. F. Drayton and Lieutenant J. G. Reed, U. S. army; and I do not regard it as an empty form to express to them, through the Bureau, my

acknowledgments for the very assiduous and efficient attention they have bestowed upon every minutia of duty entrusted to them.

Lieutenant E. B. White. U. S. artillery, and Mr. G. W. Featherstonhaugh, jr. U. S. civil engineers, have likewise assisted, very essentially, in the drawings and calculations that have been involved during the progress of my report—having been attached to my brigade since the close of our field duties.

Military and Commercial Memoir.

In regard to general considerations involved in the project of the canal around the falls of Niagara, those relating to military defences are first, in a national point of view; scarcely less prominent, however, are those which relate to the amelioration of commercial relations between the highly productive regions of the upper lakes and the northeastern States.

Regarding it as a national military work, without adverting to the precise location of the canal, (which, by reference to the routes we have surveyed, would be matter for the locating engineer, as directed by the views of the National Government,) its advantages would be to give celerity to the movement of forces, munitions of war, shipping, in a word, the material of an army between the two lakes, Erie and Ontario; which, in case of war with Great Britain, would doubtless become the scene of active operations.

The efficiency imparted to military force, derived from the power of concentrating, is a principle in strategy too well understood to need illustration. In its application to our subject, we realize its value in a conspicuous manner.

It is almost certain that in the event of hostilities between the United States and Great Britain, the naval warfare on the lakes would be extensively assisted, or, perhaps, entirely conducted, by vessels propelled by steam. In such case, their light draught of water would enable them to pass from one lake to the other with such dimensions of canal as have been projected.

This is a desideratum to which every mind must be sensible; it would impart mobility to our force, and enable us oftentimes to secure the fruits of a victory, or suddenly to repair the disasters of defeat.

By this facility the invasion of our territory, on either lake, might be prevented, with all the concomitant, desolating effects of war. A thousand modifications of circumstances might be adduced to show defeat and disaster to our arms as the result of the want of means of co-operation between our naval forces on the lakes; but I regard it as sufficient to lead the attention to this department of the subject, without occupying time with details, which must be obvious to every intelligence.

Neither ought our Government to flatter itself that the British and Canadian Government are insensible to the advantages to be derived, in such an event, from interior communication. The former has already constructed a steam-boat canal, ostensibly for military purposes, from Montreal to Kingston, and one, for commercial and military purposes, from Lake Ontario to Lake Erie.

The advantages to be derived to the British, in case of hostility, from these facilities, would be incalculable; and a commensurate caution is called for on our side to counteract their tendency. Under the administration of the Duke of Wellington a chain of communication, by steam-boat canals, was opened from Montreal to Kingston, a distance of 246 miles. These consist of, La Chine, Carrillon, Blondeau, and Grenville canals; but the project, to which these are only accessory, is the Rideau canal, extending from Bytown to Kingston, 126 miles, which alone has cost the British Government the sum of six millions of dollars, and boasts of some of the finest construction in the department of civil engineering existent in any country. Yet this is only a part of the project; and a line of military

works is contemplated to secure it against aggression, and render it an efficient channel of communication in the event of war with the United States.

The works on the Rideau canal were constructed under the direction of Colonel By, of the royal engineers, assisted by officers of the same corps. It remains under surveillance of the engineer department, and officers of engineers are stationed at Bytown, and Kingston, and intermediately, for that object. The military works at Quebec are proceeding to completion at great expense, and the garrisons at various points of their frontier are by no means neglected. These facts are not irrelevant, as demonstrating that the British Government, although in times of profound peace, regard the military position of the colony with marked solicitude.

In sections of our country having no immediate relations with the Canadas, nor interest in the changes that are operating there, the generality of persons refer to the lessons of their boyhood as the sources of information, and they regard it as a bleak, sterile, unpopulated country, and a burthen to the parental Government which sustains it. This, to a certain extent, was true but a few years ago, but the scene has changed materially, and a reference to statistic records will show that a very small portion of our own country can boast of a more rapid amelioration than has taken place in regard to the Canadian provinces.

In 1834, by an official statement it appears that the population of Upper Canada had doubled within eight years, that it is of a peculiarly valuable character, and that the development of agricultural and commercial resources has been commensurate.

A few facts will corroborate the truth of the remark. It is stated upon good authority, that of late years the annual emigration to Canada from England, Ireland and Scotland, amounts to from fifty to sixty thousand souls, and a cursory visit to that country will exhibit to us most strikingly the advantageous difference in character of that emigration, and the one which is received in our Atlantic cities from the same source, and the cause is obvious. The industrious mechanic, the laborious pains taking farmer, who, as the reward of their efforts, have enjoyed competency and comfort at home, when moved by the spirit of enterprise, do not wish to sever themselves entirely from those institutions under which they have derived those advantages; whilst the idle and improvident desire nothing so much as a change from a state of things under which they have suffered want and penury, and to which they for the most part unjustly attribute their ill fortune.

To this is to be added the great difficulty thrown in the way of the best class of emigration to this country by the British Government, with the facilities afforded to its establishment in the provinces.

It became my duty, under instructions from those to whom I was referred by the Department for my guidance during my operations of the last summer, to make myself, by personal observation, acquainted with the advance of improvement in this section of the continent.

Under these auspices, I was induced to diverge somewhat from the beaten track of visiters to the Canadas, and have verified, and can attest, the truth of the foregoing observations, but their full illustration would be necessarily founded upon details in their relation incompatible with the general nature of my report, but which, in their sum, have made a sensible and well defined impression upon my mind.

As belonging immediately to my profession, however, I cannot help in-

dulging in a comment upon some of the works of civil construction on the Rideau canal. At Bytown, Jones's falls, and Kingston mills, are certainly some of the finest specimens of hydraulic architecture on the continent of America. At Bytown are eight consecutive locks, seven of 10 and one of 11 feet lift, 133 feet long and 33 broad; these, as well as the locks at Kingston mills, are worthy of the highest admiration; but it is at Jones's falls that the most remarkable work is achieved. It consists of a dam 62 feet in height, and 400 long, in solid masonry, and among the most perfect in existence. A waste weir cut through a solid rock, and a descent of 60 feet by three consecutive locks, and a fourth with an intermediate basin. The dimensions of the locks are as those above stated, with the extraordinary lift of 15 feet, yet under the head of water consequent upon such a plan, there is scarcely the appearance of a leak, and the masonry is of the most finished and beautiful character.

I take this opportunity to express myself indebted to the frank and liberal politeness of the British officers generally, during my visit to the Canadas.

I have to thank Captain Bolton, of the royal engineers, not only for his elegant hospitality, but for the facilities he afforded me for observing many valuable modifications relating to my profession, and taking, in regard to the details of locks, &c. such memoranda and drawings as were suggested by many portions of this truly magnificent work of civil construction.

I have perhaps employed more emphasis than was necessary in regard to this subject, but I feel assured the work is scarcely known throughout the United States otherwise than by name, even to professional engineers, and much less to the community generally, to whom, in reference to the subject in hand, I cannot but think it must prove interesting.

Resuming our discussion, let us now suppose a population of the kind to which I have referred, established as it ultimately will be, in the extensive region comprised between the same parallels of latitude as Maine, New Hampshire, Massachusetts and the southern boundary of New York, and lying between Lake Superior on the west, and St. Lawrence river on the east, with Lakes Huron, Erie and Ontario on the south, possessing a climate attempered by the genial influence of surrounding inland seas, and we shall be made sensible at once of its imposing attitude, in every relation to awaken a national solicitude.

But limiting our view, it will be sufficient for our immediate object, to concentrate our reflections upon the region in the neighborhood of the St. Lawrence, and the peninsula of Upper Canada, stretching itself far into the Territory of the United States. It is this section, which will in a few years, according to the present ratio, contend with any of our most flourishing States, both in population and resources, that we have just cause to regard with a jealous eye.

By the enterprise of the Canadians, a rail-road is contemplated to connect Lake Huron with Lake Ontario. This project being carried into execution, as it certainly will be, it becomes the great portage between the upper lakes and Lake Ontario, and will have an immediate influence in concentrating population, and developing the resources of this valuable territory.

When we contemplate the maps of this region, and notice the peninsula of Upper Canada jutting into our country, and reflect that, independently of its local advantages, with those of soil, climate and population, it possesses a retired and guarded line of communication, issuing from the impregnable fortress of Quebec, in the hands of so great a military power as

Great Britain, we should not be insensible to such precautions as are calculated to increase the security of our frontier, whilst subserving in an eminent degree the cause of commerce, agriculture, and civil industry.

We are not so illusory as to interpose the Niagara canal as an *ægis* against the growing power to which we have alluded, but it should be regarded as one important measure, as concentrating population, by opening the facilities of collateral avenues, by rendering available the immense hydraulic advantages of which this point is susceptible, and by thus giving strength to this exposed frontier.

Were the National Government to purchase a site for armories, and establish foundries there, it would become the nucleus of a powerful manufacturing interest, and concentrate a population, which in time of war would be ever ready to arm in defence of its threshold, and become the most efficient guaranty against aggression.

It must not be imagined that its contiguity to the frontier would render it unsafe for such object; for supposing it to receive the attention from Government that it deserves in a military aspect, it may be regarded as one of the strongest defensible positions on our frontier.

On the west it is entirely inaccessible by means of the rushing waters, and precipitous banks of the Niagara river. To attack from the south, the enemy would be obliged to cross a considerable distance above the falls, and descend the river on the American side, through a densely settled section of country; his line of operations would therefore be attenuated, and eventually intercepted. On the east, in the supposition that the canal be constructed, its gorge would be unassailable by the interposition of a body of water of 110 feet wide and 10 deep, which would be rendered impassible by the resistance opposed, or at least produce a delay that would be incompatible with the nature of an enterprise requiring for success the greatest celerity.

The Lewiston ridge offers a barrier on the south side, which with a little attention might be rendered inaccessible. The Fort Niagara within so short a distance of the only point where a landing could be effected on the Niagara river from the opposite shore, would be a sufficient preventive to an incursion from this quarter.

A landing for such object could only be effected by the want of precaution on our side, under cover of night, and by a small number. The enterprise would certainly be cut off by a detachment from the garrison, with which this position would stand in military relation, both offensive and defensive, aided also by armed parties of the inhabitants, inspired by patriotism, and rendered vigilant by a sense of insecurity from the proximity of the enemy.

In the execution of the project also to which I refer, this manufacturing district would become the terminus of avenues leading to every part of the State. Thus an enemy of the force we refer to, once upon the high ground above the Lewiston ridge, and he would be assailed from every point with a promptitude that would render success to his enterprise, nay, an escape, impossible. With great deference we advance the opinion that a liberal policy would regard such a project as of the greatest national importance, as calculated to increase the strength of this at present assailable frontier, by augmenting its population and resources, and by providing it with arms and all the materials for defence.

The shield of national protection would be thus interposed with a

paternal care, to shelter the inhabitants of this section from the calamities incidental to their position in time of war.

But a more enlarged view may be taken in regard to the proposed project, a view in which I cannot but think the country at large, stimulated by a sense of national pride, must take a deep interest.

In the event of a war, it is apparent, from the increasing resources of Upper Canada, and the policy by which Great Britain appears to be actuated, that the most energetic efforts would be made upon the frontier, and it would be question of invasion from one side or the other, conducted upon an extensive scale; should we not become the aggressors, it is almost obvious that the enemy would soon place himself in the attitude to become so.

A true policy, founded upon established principles, dictates, that we should prepare for the contingency under any circumstances, but the more imperiously in the present instance, where the object may be effected with inconsiderable expenditure in ostensible military preparation, and without giving the slightest ground of complaint to a nation with whom we are at peace.

By the arts of peace, and for purposes of great commercial utility, we may prepare this section of the country to become, in case of emergency, a depot of inestimable value to the whole of our northwestern frontier.

From this point d'appui, in the event of invasion from our side, troops and munitions of war could afford ready reinforcements to lines of operation, diverging, as they would do, from this point of contact of the hostile territories. Under the influence of its strength and its contiguous resources, the passage of the Niagara river could be commanded both at the head and foot of navigation, below and above the falls.

In the circumstances under which Canada was placed last war, it was undoubtedly the plan to have cut the enemy's line of operations on the St. Lawrence. As Canada would then have fallen into our hands for want of resources within herself.

But the face of things has changed in regard to that country as already explained, and she would henceforward possess internal resources of no ordinary capacity; moreover, to cut the enemy's line of communication, which would be operated by the Rideau canal, and sustained by defensive works, would require a more extended line of operation on our part, greatly calculated to weaken our position in that quarter.

We should therefore be obliged to turn our attention to the invasion of Upper Canada, and with this object in view, such a point as the one to which we refer would become a principle of energy. It would give consistency to our project of campaign, by reducing our lines of operation to their minimum, inspire confidence in the militia, by the idea of the proximity of a place of support, and enable us to improve good fortune, or recover from the effects of bad.

In a word it would enable us not only to achieve victories, but render them valuable in their results.

With such resources at hand, we should be enabled to effect that greatest of desiderata, to carry the war into the enemy's country, whilst our own soil and firesides upon this frontier, should be guarantied from the horrors of invasion.

In contemplating a state of things such as this hypothesis is founded upon, I do not think my views can be deemed visionary, however tranquil may appear the horizon in this quarter, at the present moment. Indeed all

history teems with the assurance, that war is a state of things inseparable from the nature of man, springing from the causes so light in their incipiency, as to baffle the speculations, or the predictions, of the most profound political wisdom, in assigning results to the diplomatic intercourse of nations.

But waiving the idea of collision with the Canadas, it may be shown that the site referred to possesses many peculiar advantages, as a manufacturing depot to suit the most general emergencies, and the existing posture of affairs with a powerful maritime nation, may possibly give some weight to the propositions I am about to advance.

The stupendous peculiarity of its hydraulic advantages, needs no comment. I will not attempt to demonstrate what may be regarded as a proverb: it is unquestionable, that a greater water power, and that too in its application to practicable purposes, can there be commanded, than at any other point on the surface of the globe.

It is the advantages of its local position, in conjunction with its other attributes, that I shall endeavor to illustrate. For let us suppose a hostile fleet blockading our eastern and southern coast, and the communication on the seaboard entirely cut off between them, a case which obviously might occur, and then turn our reflections to the unprotected state of our Gulf coast, its present destitution of the materials necessary to its defence, and the aid it would always require in the exigency of war from the northern States; and the policy, even necessity, of its possessing some great military depot in secure and sheltered relation, becomes impressively obvious.

The district of which it is question stands in bold relief, by reference both to its central position, and the properties required.

If the attention be turned toward the map of the United States with this object in view, the mind will be struck with its peculiar advantages.

The Hudson and Erie canal passes its threshold; New York is therefore at hand. The Susquehannah, with its outstretched arms, approaches it nearly: Philadelphia and Baltimore, the Delaware and Chesapeake, are therefore its neighbors. The St. Lawrence, and the avenues to Lake Champlain, and thence the branches of canal through the Eastern States, form a continuous navigation. The vast empire of water of the great lakes is spread before it; but above all, in the sense we at present regard it, New Orleans and our southern coast, through the great valley of the Mississippi and the canals either projected or already executed, stand in a relation to it, that we think should render it a locality of peculiar national interest, and highly entitled to a portion of that public expenditure which belongs to a general system of precautionary and defensive measure.

By means of the Niagara ship canal, the Oswego ship canal, projected, and those above referred to, a secure, capacious, and expeditious medium of transit by steam navigation is opened between the chief cities of our eastern coast, and the very unprotected territory of our southern maritime frontier.

We will now advert to the commercial advantages to be diffused by the project, so far as they are of a nature by their generality, to call for the aid of the National Government. We regard as paramount the connection of the Lakes Superior, Michigan, Huron, and Erie, with the Lake Ontario, which by their extent and depth, may be severally regarded as inland seas, and which belong not to any particular State, so far as they are within our boundary, but to the entire jurisdiction of the United States. The render-

ing maritime several thousand miles of lake coast, by opening to it the only obstruction to direct commerce with the Atlantic, through the channel of the St. Lawrence, secured in equal participation by treaty to the United States.

To render the coast of the United States upon our upper lakes, in immediate commercial relation with a foreign nation bordering the lower lake and the St. Lawrence, and with our own coast on the lower lake: placing in immediate commercial relation, the United States coast of the upper lakes, with the great commercial depot of New York, through the medium of the Oswego and Hudson ship canal, to be executed by the State of New York.

With the extraordinary dimensions given to the St. Lawrence canal now executing, in conjunction with the projected Niagara canal, ships of three hundred tons might navigate from the Atlantic ocean to the ports on our upper lakes.

We may assume even that a large class of merchant ships, by a construction modified as in some mercantile nations of Europe, might be adapted to this trade.

In discussing the subject of draught in vessels, when we regard the elements which enter in assigning the burthen to any particular draught, we are not struck with any difficulty in the question theoretically, inasmuch as it is determined generally by the length, multiplied into the breadth, into the depth, either of which factors may be changed at will, and we may therefore build a very flat vessel to carry a very large cargo, by increasing two of the elements, length and breadth, and yet diminishing the third. As our plan of canal, and length of locks admit of considerable latitude in regard to the two former dimensions, no obstacle may be supposed to the adoption of a construction of vessels, that shall be calculated to carry a cargo of a magnitude within any desirable limit.

But I felt desirous of knowing whether the ordinary relative draught was not prescribed, by the consideration of practical benefits, and whether circumstances of sailing or general manageableness, did not in some measure militate against a change of model, and I therefore requested information through the medium of a gentleman whose official character gave him an opportunity of procuring the data required. The following letter addressed to the Hon. J. Turrill, from a source of undoubted respectability, establishes the proposition I have advanced.

NEW YORK, *March* 10, 1836.

MY DEAR SIR: On conferring with those who are eminently skilful in the scientific as well as those who confessedly are in the practical branches of ship building, I have gathered the following particulars, in reply to the queries of our mutual friend, McWhorter, addressed to me on the subject, with reference to the projected ship canal.

It is not necessary, in order to ensure great sailing, to give a ship a great deal of dead rise, but the contrary, as may be exemplified in simultaneously launching two ships of equal dimensions, say same length, width and depth, one with 28 inches dead rise and short floor, and the other with 14 inches with a long floor. The sharp ship will draw about three feet more that the flat one, and will require considerably more ballast, so that when all their armament, stores, water, &c. are on board, you will perceive that the sharp vessel is drawing about four feet more water than the flat one;

hence it is reasonable to infer, that the ship with the least dead rise will displace less water than the other. Mr. Webb (the associate of the late Mr. Eckford) assures me that a frigate of the largest class can be so constructed as to have all the qualities that can well be united in one ship, and be put in a condition for transporting, &c. and not to exceed a draught of twelve feet. Flat and sharp vessels may, in fact, be thus contrasted; what the one may gain by being sharp, the other acquires by extra buoyancy, losing nothing in going to windward by the *peculiar* turn in the bilge. The word peculiar I may explain by saying that great sailing may be attained by giving half an inch dead rise to every foot in width: but ships built upon this mode must have the middle futtocks crooked with an abrupt turn in the bilge, straight sides, and the thinner the ends in proportion to the draft of water, the greater the speed, and they are sure from the abrupt turn in the bilge to go to windward well, and also to steer well.

Pray inform me if the foregoing particulars are sufficiently to the point, to meet the object of your inquiries, or what other or further illustrations you require, and I will, as far as my time and my means of obtaining them admit, most cheerfully respond thereto.

Remaining, dear sir,

Yours, faithfully,

JOSEPH FOWLER.

The innovation to which our supposition refers need not excite surprise, when we reflect, that it would accomplish the object of accommodating a development of coast, such as we have stated, and possessing a back country as rich in resources as any on the face of the globe. The advantages of direct communication appear more striking when we reflect upon the great increase of expense in transportation, arising from the necessity of transhipment of the objects of trade at various points of the route.

It is stated in a report of the board of directors of the Welland canal, 1835, that, "that merchandise from London would be conveyed to Cleveland for £2 10*s* per ton, which now costs from £3 to £4, from Montreal to Prescott, a distance of 130 miles only." This, when the St. Lawrence shall be rendered navigable, by the work now constructing.

Other statements are before me entering greatly into detail, and exhibiting still more strikingly. the advantages of preserving the bulk of merchandise unbroken, from the time of its shipment until its arrival at its ultimate destination.

These are considerations involving an amelioration to commerce, by its extent and utility, worthy the patronage of a paternal Government. The Niagara ship canal is a work that in its consummation would awaken into life a thousand springs of latent resource, by the facilities it would give to the transportation of objects of agricultural and manufacturing industry; and referring to the broad principle of analogy for our support, we infer that a country, such as that which borders our upper lakes, teeming with undeveloped agricultural and mineral treasure, when brought by the facilities of steam navigation within a greatly diminished distance, by reference to time, of the emporium of New York, and other of our great mercantile cities, will receive an increment to its population, and develop its resources in a degree commensurate with the great avenues of commerce to which we refer, and surpassing all former experience.

We have practical demonstration of the increase of population, and the

consequent development of resources, in the region of the upper lakes, owing to the facilities afforded by the Erie canal, that through the State of Pennsylvania, the Mississippi river, and the various other collateral branches.

But it should be remembered, that this tide of emigration is yet incipient, it has scarcely received its impulse, whilst the avenues that encouraged the emigrant by their facilities, are arriving at their maximum of utility in consequence of the increase of commerce upon them.

It is true that a new channel is opening to these fertile regions: the outlet of the St. Lawrence. The improvements to which I have already referred in my report, namely, the Welland and St. Lawrence canals, will offer a ready means of bringing their products to a market, but the emporium they will reach will be that of a foreign nation. Montreal will enter into competition with our own markets.

It is no longer question of preventing the descent of produce from the upper lakes to Lake Ontario. The Welland canal, executed by the Canadians, has already achieved that object, and it has proven the fallacy of the reasoning, that "produce once afloat on Lake Ontario will find its way to Montreal."

It is only when the increasing amount of trade shall become more than commensurate with the facilities afforded to deliver it at the emporium of New York, or other of our eastern cities, that rivalry is to be apprehended. This has been abundantly demonstrated; for, although an entire navigation exists from Lake Ontario, by means of the Rideau, Glanville, and La Chine canals, yet by far does the greater portion of the produce of the upper lakes, and shores of Lake Ontario, find its way through the Oswego and Erie canals to New York.

The Oswego and Erie canals, in their present state, contend successfully against the competition of the St. Lawrence. But new facilities are preparing by Canadian enterprise, and the St. Lawrence canal will bring the market of Montreal nearer to the source of produce by several days, without the necessity of intermediate transhipment, thereby effecting a considerable diminution of the cost of transportation. How far this circumstance will deteriorate the value of our own channels of commerce is worthy of deep consideration.

To the sources of produce it is of course desirable to possess many outlets. But it seems clear that the policy of the State of New York would find it expedient to anticipate the demand for market way, for when its necessity shall have taught the inhabitants on the borders of the upper lakes the facilities of the St. Lawrence canal it would be difficult, if its advantages are such as are in anticipation ascribed to it, to divert the tendency of produce from Montreal.

The Hudson and Oswego ship canal is a work particularly interesting to the city and State of New York, and the State will eventually or perhaps immediately recognise it, as the true line of communication in conjunction with the projected Niagara canal, between New York and the northwestern States.

The simple fact that it saves a distance of artificial navigation of 120 miles, and only increases the absolute distance by 15 miles, and a few feet of lockage, is a sufficient element to establish its great relative economy; and this hypothesis is sustained by experience, for it appears by official returns, that there is a saving of expense, on the amount of goods trans-

ported between New York and Cleaveland, of upwards of 30 per cent. by this route over that by Buffalo, even under the present inauspicious circumstance, of a defective channel of communication around the falls of Niagara, through the Welland canal.

It should be remarked that this work is defective, both in its location and construction, not arising I infer from want of judgment in the engineers, but from the desire to complete a great project with inadequate means. In its present situation constant delays are to be apprehended in the passage of vessels, and to render it an efficient thoroughfare, would involve a very serious expenditure of money, an expense that would continually recur unless the whole plan of the work should be remodelled.

In its present state, if the Niagara canal on our side should merely be determined on, the great efforts now making by the Canadians to give to the Welland canal a greater degree of efficiency would probably be rendered unavailing, and it would eventually sink into disuse.

This effect obviously resolves itself into a consideration of great importance, and suggests the expediency of an immediate action in regard to the measures herein recommended.

The next commercial benefit to be derived from the Niagara canal is that which relates to the northeastern portion of our country, by the Ogdensburg canal, and by the St. Lawrence and Plattsburg canal, which have been already projected, and which would doubtlessly be executed in the event to which we refer, the produce of our far west would be conducted to the waters of Lake Champlain, and thence by the projected La Morelle canal, Montpelier canal, Passumpsic canal, &c. to every section of New England, and in return a most economical outlet would be presented for the active manufacturing and productive industry of that enterprising portion of our country.

It would be impossible, without rendering our report too voluminous, to enter into detail in regard to the various ramifications of commercial enterprise, that would, in all probability, receive an impulse, should it become an object of national interest, to remove the barrier in an efficient manner between Lake Erie and Ontario, improve the harbors upon their extensive coasts, effect the communication between Lake Michigan and the Illinois river—in a word, by its paternal influence, constitute the national waters of our northern lakes, a common market way to the various States bordering upon them, or enjoying their influence in a less immediate degree.

In order to avoid enumeration of details I have appended to the accompanying map of the survey, a general map of the States, to which my report has reference, showing the various canals projected or executed. It will exhibit at a glance the relative dependence of many of them for increased success upon the removal of the obstruction to navigation between the two lakes, Erie and Ontario, it will likewise illustrate certain passages of my report referring to the provinces of Upper and Lower Canada.

The various topographical data in regard to the lakes, are marked upon the map. A comparative estimate is also noted of the development of coast bordering these inland seas, and that of our Atlantic and southern coast. By this it appears that the length of the lake coast exceeds the whole extent of that of the Atlantic, from Passamaquoddy bay to Sabine river, by two thousand miles.

Of this development of lake coast, the portion on Lake Ontario will be united to the ocean by a ship canal on the St. Lawrence, to which I have already referred.

The remaining portion is separated, in regard to steam-boats and ships of moderate burden, by the obstruction on the Niagara river, to which my report refers.

The territory that would be sensibly benefited, under the hypothesis of this removal by the plan proposed, would be, principally, New York, Ohio, Michigan, a portion of Pennsylvania, Virginia, Indiana, Illinois, Kentucky, Missouri, and even, remotely, the Northwestern Territory. Moreover, the sphere of commercial transit upon the great channel of the Mississippi will, by the facilities of this project, be greatly enlarged. A steam-boat navigation from New York to New Orleans, would open a new era in the destinies of the southwestern States of our confederacy. We cannot, I think, refer wi too much emphasis to the projected ship canal between Lake Michig and the Mississippi, by the Des Plaines and the Illinois river.

The project is ably treated in a letter from the United States Chief Engineer, in answer to a call for information from a member of the United States Legislature upon that subject. The distance between New York and New Orleans by this route, and that by sea, around Cape Florida, as deduced from Tanner's map of the United States, is nearly the same; but when we reflect upon the dangerous navigation, and the increased distance by the divergency of the ship from her proper course, arising from adverse winds, which, by reference to the going and return voyage, must be estimated at one-fourth, we must be forcibly struck with the advantages that the combined project would afford to the commercial intercourse between New York and the great emporium of the South, and the idea it suggests of healthful action to the commercial and agricultural relations of the intermediate points.

The distance we have carefully measured, on the map, between New York and New Orleans, by way of Oswego, Niagara, Maumee, and Wabash canal, and it amounts to two thousand and eighty-five, whilst the distance around the Florida coast is two thousand two hundred and fifty, leaving a balance in favor of the lake route of one hundred and sixty-five miles.

Another branch of my report relates to the advantages to be derived to the General Government, by the facilities given to emigration, and bringing, by respect to time, a remote and unpeopled frontier in closer contiguity with more densely inhabited and civilized regions, thereby enhancing the value of the public domains, and procuring for them a more ready and advantageous sale.

This consideration is of more importance than might appear from first glance. When we reflect that the economy of a journey depends, in so great a degree, upon its continuity and despatch; delays at points of a route, where conveyances are changed, obliging the emigrant to incur the expensive charges of cities or towns, are a barrier to emigration; because the expenses of the whole route cannot be calculated previously to departure, and a consequent apprehension is inspired to many of the poorer classes, who eventually exhaust their resources in the cities where they debark, and, by compulsion of poverty, remain there; thus, instead of becoming a valuable accession, by their labors, to the thinly populated territory of the west, they oftentimes become a burden and expense to the community which has the misfortune to receive them. The project in question, with the Oswego and Hudson canals, would afford a cheap, continuous, and rapid mode of transportation, by steam, from New York to the remote public domains of our upper lakes.

In conjunction with the St. Lawrence canal, Montreal and Quebec would stand in a similar relation; and those great recipients of European emigration would send forth, with renewed impulse, their thousands, to render many a tract of wilderness the abodes of industry, social happiness, and refinement.

A consideration of very great importance, and of a character calling for an amelioration, is that which relates to the shipping interests of the lakes under existing circumstances. The vessels navigating the lakes are, during the rigors of winter, blocked in their harbors by the ice. By this means a large amount of capital, invested in shipping employed on the lakes, is neutralized for several months of the year. A deterioration of property, proportionate thereto, ensues, and the deprivation of employment of a valuable class of citizens in the seamen by whom they are navigated. This would be remedied by the proposed project, in conjunction with the Oswego and Hudson canals, or even independently of the latter, by the project a steamboat canal, now executing on the St. Lawrence river, under the auspices of the Canadian Government. Should the Niagara ship canal be constructed, the shipping interest of the upper lakes would participate in this advantage.

This remark applies with equal propriety to Government vessels that, in any contingency, may be built and employed upon the lakes, when the service upon which they might have been required there shall cease.

They could, by the means we suggest, be lightened of their armament, and brought down to our eastern seaboard for other employment. The full force of this suggestion would have been felt at the expiration of the last war with Great Britain, when our naval preparations upon the lakes became entirely useless, and a dead loss to the nation.

I have now completed a cursory review of such general considerations as have appeared to merit, in my estimation, the notice of Government. In this I have endeavored to avoid minutia, foreseeing that they would render my report both fatiguing and voluminous. My desire has been rather to call attention to the various points upon which an argument might be based, than to take upon myself the task of development.

I have also felt, in the course of my remarks, that too much detail would but embarrass the natural course of thought, and that the subject itself, if brought to the reflection, would carry conviction in its train. If I have shown more interest in the question than is usually looked for at the hands of the engineer, it is that I have felt the strongest conviction of the grandeur, even sublimity, of the enterprise, combined with its general usefulness to the country, and the facility of its execution.

I have now the honor to submit the present memoir, with the various plans, maps, profiles, and other illustrations, connected with the survey.

I am, sir, most respectfully,

Your obedient servant,

W. G. WILLIAMS.

Capt. U. S. Top. Engineers.

3 MAPS 4 PROFILES TRANSFERRED TO GMT